POWER

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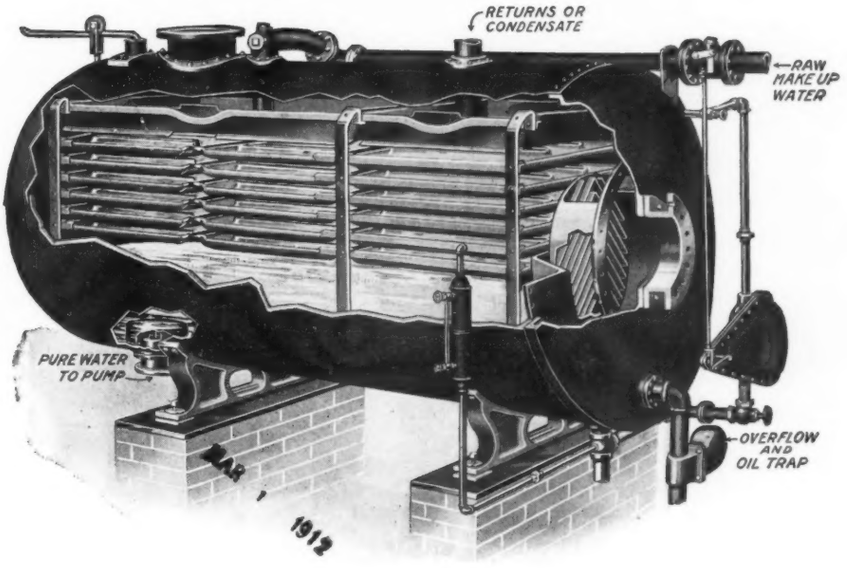
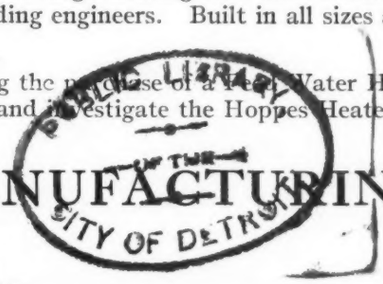
HOPPES DOUBLE SERVICE
Feed Water Heater



To obtain the best results in the purification of the boiler feed water it is often necessary to keep the raw water and the returns separate while passing through the Heater. Illustration shows how we have accomplished this feat. The returns are passed over a separate tier of pans and not brought in contact with the raw water, until both reach the storage chamber in the bottom of the Heater.

Hoppes Heaters heat the water to 212° F. and are the most efficient on the market, owing to their large heating and lime catching surface. Used and recommended by leading engineers. Built in all sizes and types, ranging from 50 to 40,000 H.P.

If you are considering the purchase of a Feed Water Heater it will pay you to send for our catalog and investigate the Hoppes Heater.



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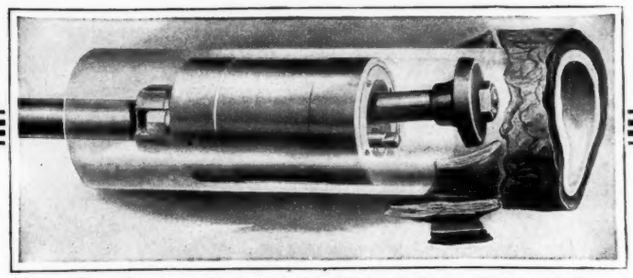

The Dean Removing Scale from the Tube of a Return Tubular Boiler

Then and Now

The way an engineer used to fight scale won't do today.

A story will illustrate.

Ten years ago an engineer started operating four brand new boilers.

He thought he would keep them clean by using compounds.

$300.00 a year right there.

For a reason which he didn't recognize at first, the boilers didn't maintain their rated H.P.

Nowheres near it.

Meanwhile the fuel consumption increased.

Then, every now and then there was a leaky tube to be attended to.

He finally guessed it might be scale that was causing all the mischief.

How did he go about to solve the problem?

Did he order a

Dean Boiler Tube Cleaner

and try it on one of his boilers?

Not on your life!

He was afraid it would injure his tubes—the compound people told him it would.

He swallowed it—hook and all.

A different brand of compounds this time!

Results? Yes, as long as acids constituted one of the ingredients. When they were eliminated 'twas the same old story.—FAILURE.

Imagine a live, wide-awake engineer fighting scale like that today!

If you want to know how 12,000 up-to-date engineers are fighting scale today with the DEAN—producing positive, tangible results—saving money for their companies—getting real value for their money—write for Booklet No. 130.

Why not try the DEAN?

Free Trial Offer

We'll loan you a DEAN for free trial in one boiler. We won't hurry you with the test, force the cleaner on you, nor get sore if we don't effect a sale. We simply want you to see what a money-saving proposition we have. Then it's up to you to decide what to do with it.

THE WM. B. PIERCE CO.

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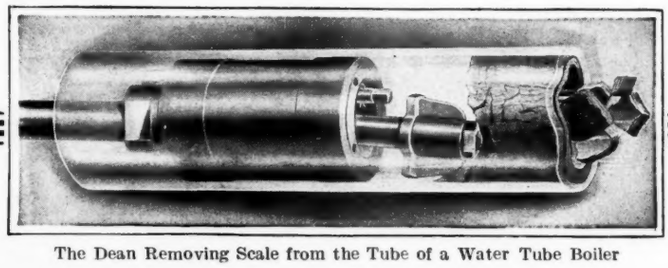

The Dean Removing Scale from the Tube of a Water Tube Boiler

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With Keystone Users Everywhere

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We've a certain jovial Irish salesman who regularly makes a certain town—never mind just what town—and as regularly calls on a merry compatriot—an engineer—there. And every time he calls a conversation something like this ensues:—

"The top-o'-the-mornin' to you. Y're looking fine. What have you been doing? Usin' that Keystone Grease on y'r own old carcass? I know it's the finest thing in the world for engines and machinery and I don't believe there's anything else that would make ye step around as lively as ye are this mornin'. You must a' been rubbin' it into your stiff old 'jints' to limber 'em up for runnin' after O'Brien's Kitty."

We've never tried Keystone for "stiff old jints"; but we do know there is no bearing too large, too heavy, too awkwardly placed or in which the rotative speed is too high, that cannot be perfectly lubricated with Keystone Grease.

Try Keystone Grease—at our expense—and see for yourself.

Just fill in and return the coupon and get the free can of Keystone Grease, Grease Cup and Engineer's Cap. Use the "Keystone" on your hardest bearing and we'll rest on the results.

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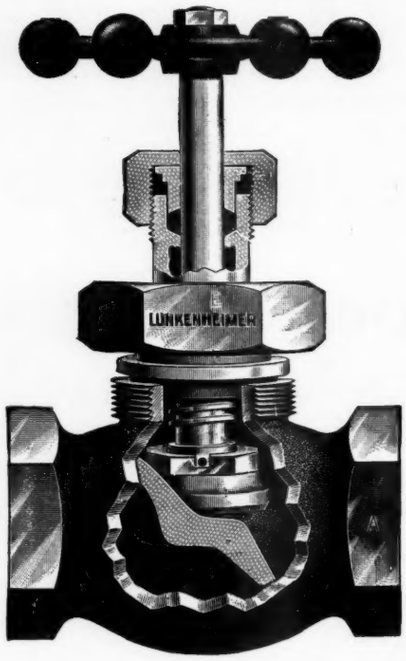
Please send us a large size sample of Keystone Grease, sufficient for testing purposes, and one Brass Grease Cup and Free Engineer's Cap. It is thoroughly understood that no charges whatsoever will be made for sample, cup or cap, and all express charges will be paid by you.

Name of bearing where sample will be tested.....
Its width..... Combined horsepower of engines.....
Tap size of cup.....
FIRM.....
Per .....
City ..... State.....
Size cap required.....

CUT OUT THIS COUPON AND MAIL IT TO-DAY Dept. B—2-27-12



Lunkenheimer Regrinding Valves

have invariably maintained a reputation for quality of the very highest,—and justly so, because they are absolutely dependable, are made of the best grade of only new material, and by skilled mechanics in the shops of The Lunkenheimer Company, whose reputation for quality is universally acknowledged.

These valves require no extra parts when the seating faces are worn. They can easily and quickly be reground, making them as tight as when new, and this process does not necessitate the removal of the valves from their connecting pipes.

The union connection between the body and hub permits the valve to be quickly and easily taken apart for regrinding or repairs, and also protects the uniting threads from the corroding action of the steam.

LUNKENHEIMER REGRINDING VALVES can be packed under pressure when wide open, and the areas throughout the bodies are largely in excess of the nominal diameter of the connecting pipes.

The valves are made in two styles:—one with inside screw and the other with outside screw and yoke,—and in two weights,—Medium Pattern, for working pressures up to 200 and Extra Heavy for pressures up to 300 pounds.

Specify and insist upon securing the genuine Lunkenheimer make. Do not accept substitutes—they are never as good as the genuine.

"MOST supply houses sell them—yours CAN—if they DONT or WONT—tell US"

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3

The Economy Of Dearborn Treatment

Reduces Power Plant Troubles

Being made to suit the exact feed water conditions prevailing in your plant, Dearborn Treatment is always successful.

It settles your boiler scale problem once and for all. It puts a complete stop to all the worry and trouble that scale always causes.

It keeps the boilers clean continually without demanding tribute in the shape of night and Sunday work on your part.

You'll never need to experiment with this device and that, nor need to try so called scale cleaning devices on trial, only to be disappointed in results.

It puts an end to all scale troubles. It lowers the cost of power; it saves its cost several times over every year in coal saving alone.

Send us a gallon of your feed water—in any kind of a container so long as it's clean before you put in the water.

We'll analyze it—find out what scale forming elements it contains—and send you some facts about treatment made for your particular needs, that will interest you.

Send the sample today.

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Robt. F. Carr, Pres.

General Offices, Laboratories and Works
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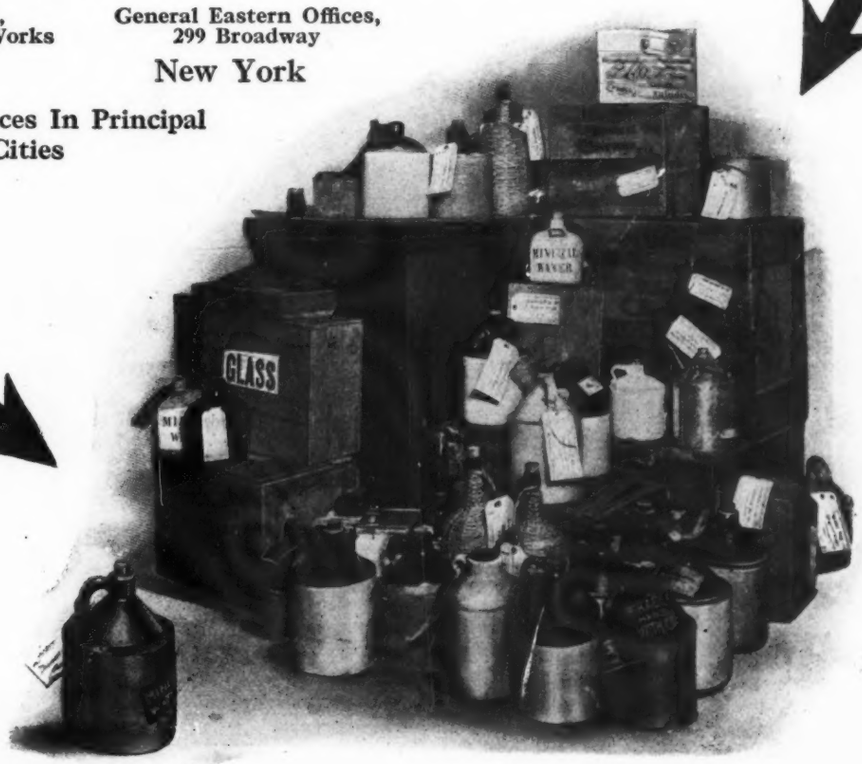

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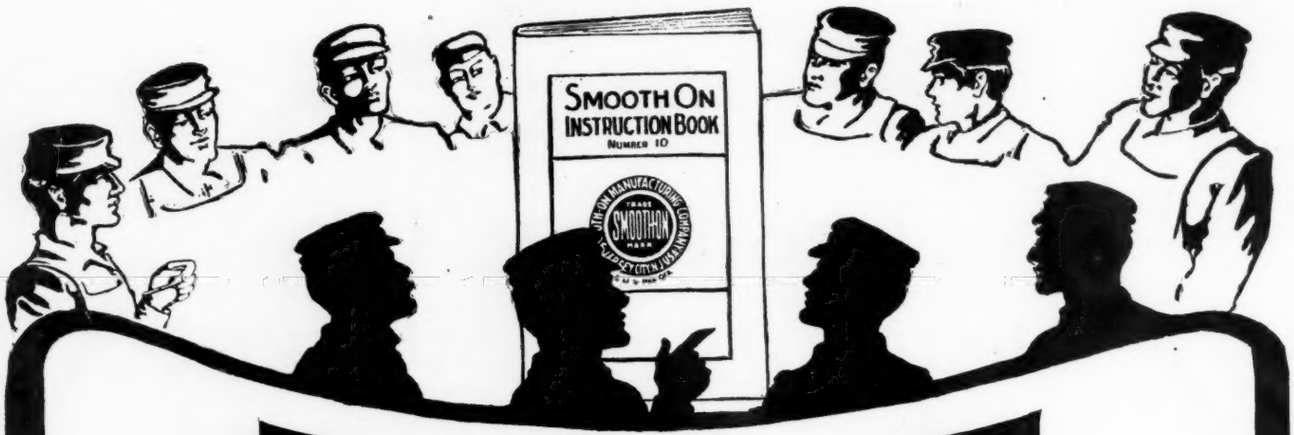

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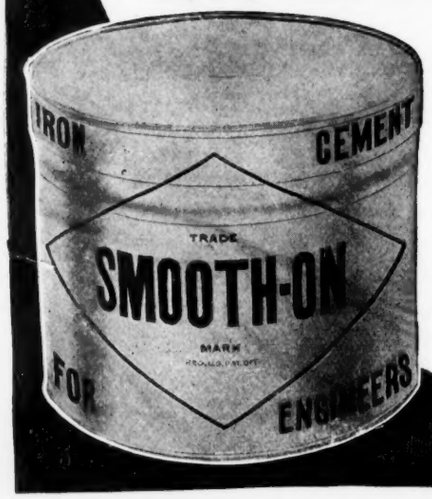
SEND FOR IT TODAY.

This book should be within instant reach of every engineer. It tells clearly, by photograph and formula, how to use the well-known Smooth-On Iron Cements in repairing boilers, engines, castings, tanks, joints, etc.

Used according to instructions, Smooth-On Cements will save more actual time and money in the engine and boiler room than any single product manufactured. Their uses are innumerable, and their repairs absolutely permanent.



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POWER

Vol. 35 NEW YORK, FEBRUARY 27, 1912 No. 9

You can show the boss that you are worth more money and you can get it, always providing that you actually are worth more. Maybe you may not succeed in getting it from the present boss, but somewhere there is a boss who wants your talent in his service and is willing to pay you what you are worth —again, always providing you have the talent, and use it.

We can hear some skeptics saying, "Aw, this is all nonsense. All employers are alike, they want you to work for the lowest wages regardless of what you are worth."

You are wrong, skeptics, you deceive yourselves. The nib of the whole matter lies in this fact: it is almost a universal human failing to overestimate one's own worth.

If you are receiving $1000 per year and secretly you believe you are worth $2000, and can't get it, you naturally feel that all employers are persecutors and—well, what's the use anyhow!

Now, the thing to do before arriving at such a conclusion is first to prove, honestly, that you are worth the $2000. Prove it to yourself beyond a shadow of a doubt. Pick out a $2000 man and see how you weigh up with him. Are you producing as good results as he? In a crisis, could you bring as much knowledge and experience to bear as he?

Ten chances to one you will find yourself lacking in some respect or other. If so, the thing to do is to build yourself up in those weak spots—make yourself grow to the $2000 size.

Then, the next thing to do is to deliver $2000 worth of service—apply your knowledge, experience and talents so that the results will be worth a full $2000 to your boss. Because he pays you only $1000 is no argument for stopping when you have delivered $1000 worth of service. If you do stop at the $1000 point, how is the boss to know that you are worth twice as much? Do you think he is a clairvoyant and ought to come to you saying, "Although you only deliver $1000 worth of goods I know you are worth more money, and so I will raise your pay, hoping that you will get a hustle on and make good"? No! He is "from Missouri"! You must show him that although he hates to pay you more money, it is to his best interest to do so rather than have you leave to take a position where the pay is what you are worth.

Engineers' wages range all the way from a dollar and a half a day to $10,000 per year and upward. And right here it may be well to repeat that there is plenty of room at the top. The higher you go, the less competition you will have, and hence the easier it will be to collect what your services are worth.

However, wishing will not get you there, nor kicking.

Honest hard work and study pave the way, and upon the quality of this pavement depends the rapidity of your upward travel.

Hebrew Infant Asylum Power Plant

By Warren O. Rogers

A good example of a small, modern isolated power plant.

The equipment consists of air washing and heating apparatus, with automatic control of the hot and cold air supply; also the necessary steam- and power generating units.

When the Hebrew Infant Asylum, of New York City, was opened for occupancy on Feb. 19, 1911, one more isolated plant was put in operation, and, from the character of the equipment, Chief Engineer Culley should have no trouble in producing electrical energy at a figure not approachable by the central station.

The main building has been erected on a plot of ground at Kingsbridge Road and Aqueduct Ave., New York City. It is five stories high, with a basement, and is constructed of red pressed brick with granite trimmings. An isolated and smaller building, used as a hospital, is located at the rear of the main building, the only connection between the two being an underground tunnel, in which steam and water pipes, electric wires, etc., are run.

The institution is provided with a power plant, including engines, boilers, pumps and other apparatus forming a complete power, heating and ventilating equipment for the buildings.

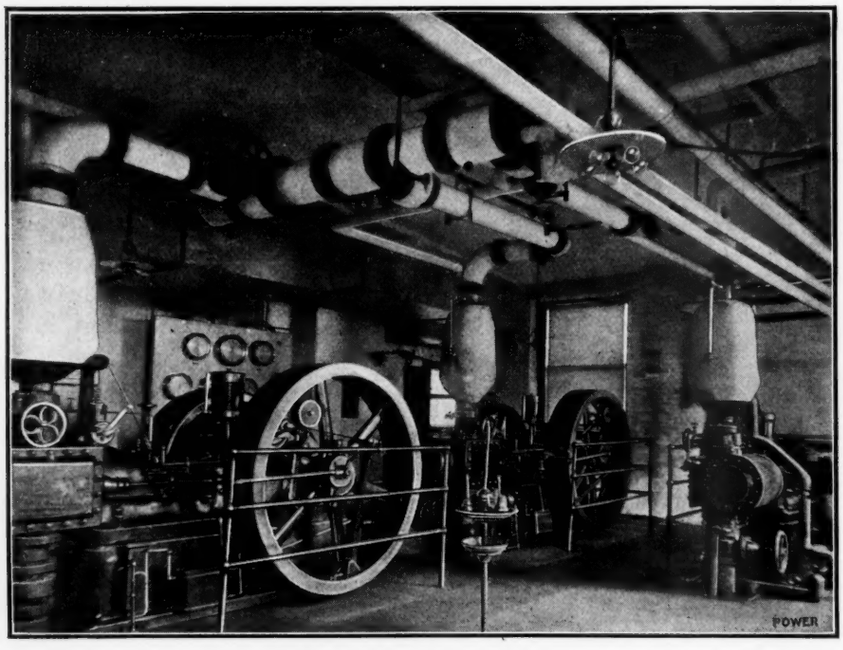


FIG. 1. THE ENGINE ROOM

ENGINE ROOM

The engine room, shown in Fig. 1, is built slightly below the ground level on the Aqueduct Ave. side of the building. In it are two 14x14-in. center-crank engines, each direct-coupled to two 100-kw. and a 75-kw. direct-current generator respectively. The two large engines run at a speed of 250 r.p.m. and the small unit at 275 r.p.m.

At one end of the engine room is a five-panel direct-current switchboard upon which are mounted the necessary switches, voltmeters, ammeters, etc., for the control and distribution of the electrical energy. It is shown in Fig. 2.

BOILER ROOM

Each of the three 150-hp. water-tube boilers is fitted with a 4-in. nickel-plated pop safety valve which is set to blow at 125 lb. pressure per square inch. The furnaces are fitted with improved grates, the bars having a double cutoff movement, and are designed to burn buckwheat coal. The boilers are connected to the vertical smoke flue by means of a rectangular wrought-iron breeching of equal area to the combined damper area and is made of No. 10 gage wrought iron. It is supported from the ceiling of the boiler room by wrought-iron hangers and angle and T-irons.

Each boiler is fitted with a damper, but a separate damper in the smoke flue governs the draft of all boilers and is controlled by a damper regulator.

Coal is delivered to the boiler room in a 1-ton coal car which runs on an industrial track, the rails of which are set flush with the concrete floor.

Under the grating in the boiler room and next to the engine-room wall is a 500-hp. vertical feed-water heater. There are also a boiler tank and grease extractor which permit the water of condensation being used over again as a boiler feed. The boiler blowoff pipes are connected to a steel blowoff tank 3 ft. in diameter by 3 ft. 6 in. long which is placed below the blowoff valve. The drips from all the engines and pumps are connected to this tank. A 3-in. vapor pipe is connected to the tank and is carried to a 4-in. main vapor line which is placed in the vertical smoke flue and discharges to the atmosphere above the roof.

The discharge from the tank is connected to a sump and the contents are pumped by means of a sump pump into the sewer. The blowoff tank is provided with cooling coils constructed of seamless brass pipe. The water in passing through these coils is heated and is then carried to the house and used for a hot-water house supply. All water used in the buildings is filtered by passing through sand and charcoal filters.

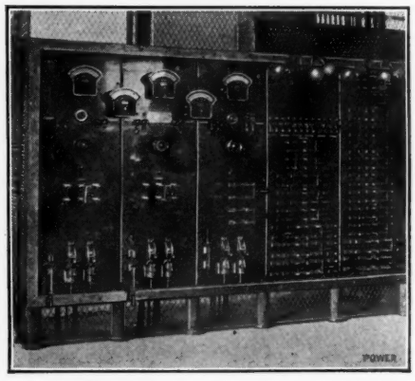


FIG. 2. THE SWITCHBOARD

PUMPS

All pumps are set on a brick foundation, each having a 4-in. bluestone cap. The house-service pump is 6 and 4 by 6 in. in size and is cross-connected with the boiler-feed pump so that it can be used for boiler-supply purposes if necessary. It is controlled by an automatic governor which operates with a float in the tank. There are two 6 and 4 by 6-in. outside-packed boiler-feed pumps. They can also be used for returning the water of condensation from the heating system to the boilers. Fig. 4 shows a section of the pump room.

The underwriter fire pump is 10 and 6 by 12 in. in size and is used entirely for fire protection to the building. It is cross-connected with the house pump.

Piping

Each boiler is connected by a branch outlet to a 12-in. header, as shown in Fig. 3, from which connections are taken for all engines, pumps, air compressors, etc. Valves are placed on the exhaust pipes of all engines, pumps and air compressors, and from these valves connection is made to a 12-in. main-exhaust header, from which a 10-in. branch extends to the feed-water heater. A 12-in. pipe runs through a muffler tank and connecting to a back-pressure valve rises to the roof. The exhaust piping of all the small pumps in the boiler and engine rooms is grouped and connected to a 6-in. outlet on a 10-in. branch pipe running to the heater. Two feed pumps are connected to a 3-in. brass pipe which extends to the top of the boilers in the front and connects with the boilers through a 2-in. brass pipe.

An interesting arrangement of high-pressure piping is shown in the illustration, Fig. 5. This is known as the drop-leg system, which takes care of all the condensation in the pipes and also allows for their expansion and contraction. It will be noted that at each drop leg the bottom elbow is fitted with a drip pipe which connects with the return pipe. About midway of the tunnel is a double-expansion bend which is designed to take care of expansion of the pipe in both directions. This arrangement of piping was designed by Chief Engineer Culley.

Incinerator

In the basement at the rear of the boilers there has been provided an incinerator for burning the waste from the kitchen, etc. This is constructed of masonry with cast-iron doors and is 5x10 ft.; the height is 8 ft. The grates are 24 in. wide and 36 in. deep. Back of the furnace grate there is a dumping grate 24 in. wide by 30 ft. in depth which is operated by a lever from the front.

Heating System

Both buildings are heated by the direct and indirect system. The corridors, halls, bathrooms and sleeping rooms are heated by the direct system and all reception rooms, wards and children's play rooms are heated by the indirect system. Both systems are controlled by automatic regulators and work with a variation of 1 deg. F. either way. A temperature of 70 deg. F. is maintained. For direct radiation there is a total of 125 radiators with an average surface of 75 sq.ft. The indirect system has a total of 70 radiators or stacks with an average heating surface of 125 sq.ft. These heating coils are hung from the ceiling of the plenum chamber and are incased with a sheet-iron jacket and flue connection to the flue leading to the room to be heated. The heat is controlled by a double damper which admits hot or cold air to the room as the temperature falls or rises, each room being equipped with a thermostat directly connected with the damper.

The direct radiators are connected to sets of risers, 42 in all, located in such parts of the building as to make the connections to the radiators as short as possible. Each radiator has steam-return and air-line connections. The 8-in. main heating supply passes from the boiler room to the plenum chamber, from which connections are made to the risers and stacks. Return lines from all risers, radiators and stacks are connected to a main 6-in. return which follows the course of the steam main and enters the feed-water heater in the boiler room.

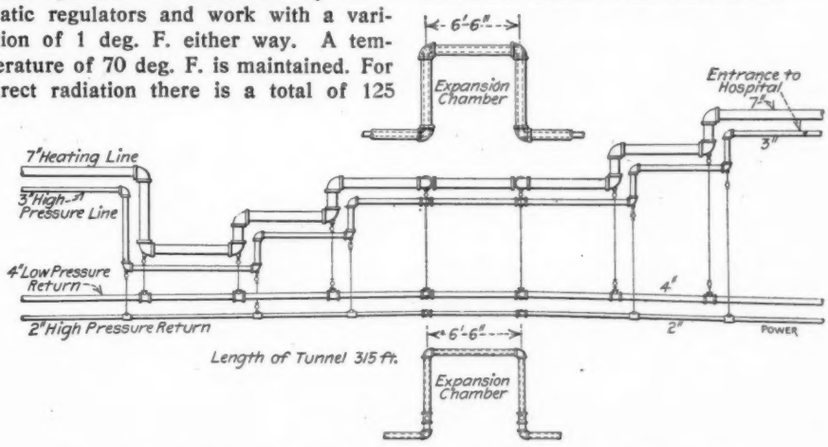


Fig. 5. How Expansion of Piping Is Taken Care of in the Tunnel

Ventilating Apparatus

The ventilating apparatus provides for the fresh cold-air supply for the boiler and engine rooms and a warmed fresh-air supply throughout the building. This apparatus also provides an exhaust ventilation from these rooms by means of exhaust fans which are located in the attic. In the basement there are two centrifugal cone-pressure fans which are used for supplying air to the entire building.

The 84-in. ventilating fan is driven by a 12½-hp. motor and each 78-in. fan is driven by a 10-hp. motor; both are of the multipolar, direct-current type. Before entering the fan, the air is washed by

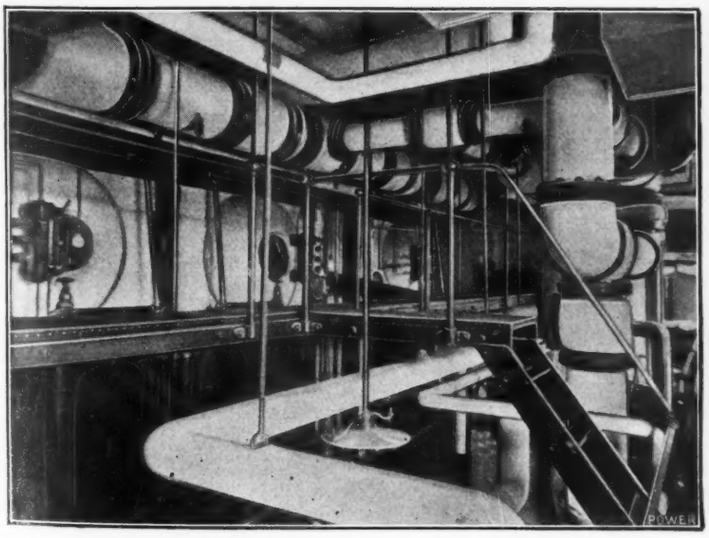


Fig. 3. Piping in Boiler Room

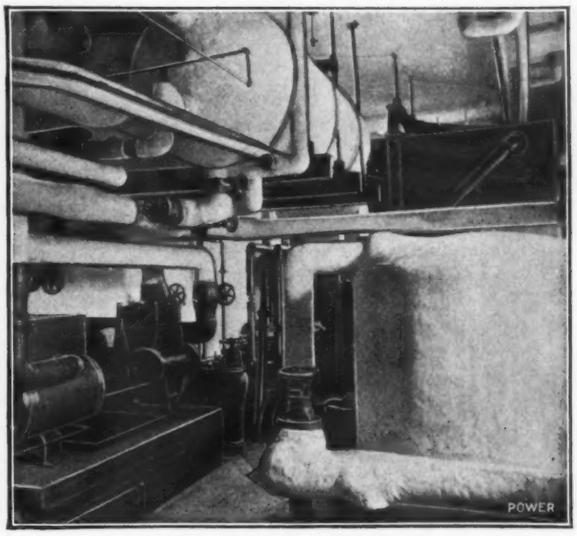


Fig. 4. Pump and Filter Room

passing a sheet of water between the inlet and the fan proper.

The filter is capable of washing and cooling 60,000 cu.ft. of air per minute and delivers it at a temperature not exceeding 5 deg. above the temperature of the water used. Before passing through the various rooms of the building, the air is tempered by means of indirect radiators which are built in four groups of tempering coils of 19 sections each, having a total of 2850 sq.ft. of heating surface. Each of the 19 sections has separate steam returns and air connections. Each air flue is connected to the main plenum chamber.

Double dampers control the admission of either hot or cold air, and they are controlled by air pressure. As the temperature falls a thermostatic valve admits the air to a valve controlling the compressed-air diaphragm which operates the damper. As the temperature in the room rises the hot-air damper is closed and the damper controlling the cold-air supply is opened, and *vice versa,* thus keeping the temperature of the room normal. This arrangement permits of controlling any indirect radiator by means of the double damper at the base of each of the 68 flues or reheating stacks, and a thermostat is placed in the room corresponding to that with which the flue connects.

The pneumatic thermostats are located at a height of about 5 ft. 6 in. from the floor in such parts of the room as will best serve to give the average temperature. The thermostats open and close the dampers to which they are connected by compressed-air pipes.

The power plant operates with a day-and-night load. It is very complete and furnishes a good example of a small modern isolated power-plant installation.

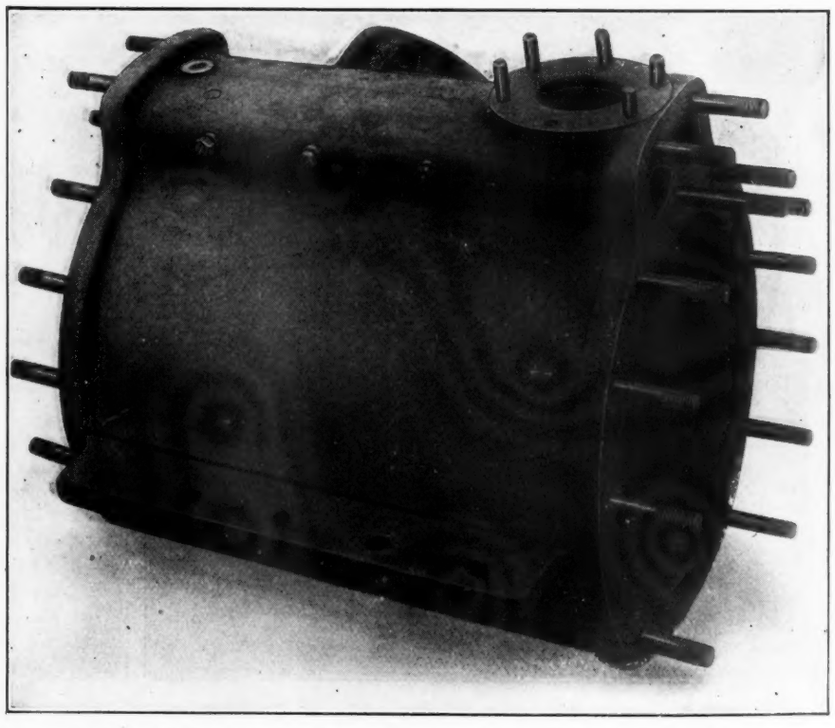
EQUIPMENT OF POWER PLANT

Equipment	Make	Purpose	R.p.m.	Horse-power	Steam Pressure, Lb.	Kw. Capacity	Volts	Amperes	Size, Inches	Manufacturers
2 engines	Ames	Main generator units	260	...	125	200	...	...	15x14	Ames Iron Works
1 engine	Ames	Main generator units	275	...	125	75	...	...	14x12	Ames Iron Works
3 boilers	Babcock & Wilcox	Steam generator units	...	150	125	...	...	...	...	Babcock & Wilcox Co.
2 generators	Sprague	D.-C. generators	260	...	...	200	245	800	...	Sprague Electric Co.
1 generator	Sprague	D.-C. generator	275	...	...	75	245	300	...	Sprague Electric Co.
3 safety valves	Consolidated	Boilers	...	...	125	...	...	...	...	Consolidated Safety Valve Co.
Grates	McClave	Shaking and dumping	...	...	...	...	...	...	...	McClave-Brooks Co.
Regulator	Kieley	Damper	...	...	...	...	...	...	...	Kieley & Mueller
Heater	Utility	Feed water	...	500	...	...	...	...	...	Standard Steam Specialty Co.
2 separators	Utility	Steam mains	...	...	...	...	...	...	5	Standard Steam Specialty Co.
1 separator	Utility	Steam main	...	...	...	...	...	...	4½	Standard Steam Specialty Co.
1 pump	Deane duplex	House service	...	...	100	...	...	...	6x4x6	Deane Steam Pump Co.
2 pumps	Deane duplex	Boiler feed	...	...	100	...	...	...	6x4x6	Deane Steam Pump Co.
1 pump	Deane duplex	Fire and tank	...	...	100	...	...	...	10x6x12	Deane Steam Pump Co.
2 pumps	Duplex	Air	...	...	100	...	...	...	...	Johnson Service Co.
Heating system	Johnson	Air and steam	...	...	...	...	...	...	...	Johnson Service Co.
4 fans	Duplex Cone	Ventilation	225	...	...	...	...	...	78	Howard Morse Co.
1 fan	Duplex Cone	Ventilation	200	...	...	...	...	...	84	Howard Morse Co.
2 fans	Duplex Cone	Ventilation	425	...	...	...	...	...	36	Howard Morse Co.
4 motors	Sprague D.-C.	Driving fans	450	...	...	...	...	...	...	Sprague Electric Co.
2 motors	Sprague D.-C.	Driving fans	425	...	...	...	...	...	...	Sprague Electric Co.
1 motor	Sprague D.-C.	Driving fan	450	...	...	...	...	...	...	Sprague Electric Co.
Valves	Jenkins	Piping system	...	...	...	...	...	...	...	Jenkins Bros.
Pipe covering	Asbestos	Steam, hot water	...	...	...	...	...	...	...	Robert A. Keasley Co.
Gage board	Baldwin	Steam and air	...	...	...	...	...	...	...	Baldwin Engineering Co.
9 gages	Ashcroft	Steam, vacuum and air	...	...	...	...	...	...	...	Ashcroft Mfg. Co.
Piping	Extra heavy	Steam and water	...	...	...	...	...	...	...	Baldwin Engineering Co.
5 traps	Kieley	Return	...	...	...	...	...	...	...	Kieley & Mueller
7 traps	Angell	Return	...	...	...	...	...	...	...	Angell Mfg. Co.
Water control	Cutler-Hammer	Motors	...	...	...	...	...	...	...	Cutler-Hammer Mfg. Co.
Meter	Worthington	Water	...	...	...	...	...	...	...	Henry R. Worthington
3 lubricators	Rochester	Force feed	...	...	...	...	...	...	...	Greene-Tweed & Co.
2 filters	Roberts	House water	...	...	...	...	...	...	...	Roberts Filter Mfg. Co.
Air purifier	Kinealy	House supply	...	...	...	...	...	...	...	Kauffman Heating & Eng. Co.

Patched Air Compressor Cylinder

An ingenious repair job was recently made on an air-compressor cylinder at the No. 7 colliery of the Susquehanna Coal Co., Nanticoke, Penn.

For some unknown reason, water accumulated in the air-exhaust port of the cylinder and when the compressor was started the outer shell was cracked on both sides, as shown in the accompanying illustration. It was a case of making a hasty but permanent repair and Master Mechanic Morgan decided to reenforce the fractured part through the top and sides by means of solid stay-bolts. The stay-bolts, running from the top of the air port, extended but part way through the cylinder wall. A second set was run from the side walls of the exhaust port, as shown. The crack was then dovetailed with a cold chisel and plugged with strips of copper.



STAY-BOLTS TO STRENGTHEN CRACKED EXHAUST PORT OF CYLINDER

This repair job has lasted for three years and the cylinder was recently removed in order that it might be rebored, when it will again be put in service.

The Systematic Purchase of Coal

By F. R. Hutton* and J. L. Pultz†

An outline of the procedure employed in the selection, purchasing and use of coal for the Department of Water Supply, Gas and Electricity, New York City. With slight modifications these methods may be applied to any municipality or large user of coal.

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†Consulting engineer and member of the Standardization Committee of New York City.

The systematic purchase of coal as here considered includes, first, the purchase of fuel which shall insure a maximum heating value and furnace effectiveness with a minimum operating cost, and, secondly, a systematic procedure governing the delivery, sampling, analysis and payment for coal. The procedure and its detail will not be justified in cases where the fuel required can be obtained without the use of detailed specifications. Such conditions would occur when a power plant buys direct from an operator who handles coal from a certain locality and of a desired quality. This is unquestionably the most simple method of purchase. In centers of population which draw their coal supplies from various localities, and where the coal is sold under various trade names in the local market, municipalities and large corporations have disregarded such terms, and the more scientific method of buying by analysis and heat value has been considered worth the additional trouble.

In the practice of the United States Government the contractor is paid a bonus for coal delivered which is of better quality than the standard set in the specifications. For deliveries of coal which fall below that standard, deductions are made from the contract price, proportional to the decreased value of the coal. The advantages for this system may be summarized as follows:

1. The buyer is insured against delivery of poor and dirty coal, and is saved from disputes arising from condemnation based on a visual inspection.
2. Bidders are placed on a strictly competitive basis as regards quality as well as price.
3. Trade names are ignored and the field for both buyer and dealers is broadened.
4. Delays and cost of removal are avoided should the delivered coal prove to be of poor quality after the expense of such delivery has been incurred. Rejectable coal may be accepted if its removal is inexpedient, although at a greatly reduced price.
5. A definite basis is provided for a cancellation of the contract.
6. The inspection and analysis at the intervals of installment deliveries make an easy check on the practical results in burning.

The objections in practice to the bonus feature of any system may include:

1. The quality of coal which entitles the dealer to a bonus can often be obtained without one, unless the standard is made so high as to admit too few bidders.
2. The range between the quality entitling to a bonus and that entailing a penalty may cause so wide a variation in the quality supplied at any consuming point that difficulties arise from the labor point of view in hand firing, and in securing the highest efficiency with the equipment of the plant.
3. The contractor will always see his risks of loss more clearly than his possible premiums. Therefore, he will put his price high enough to protect himself, and this is the same as raising the point when penalties will begin.
4. The bonus system puts great responsibility on the inspectors in sampling and on the chemists in their analyses.
5. The bonus system has been shown by experience in some cases to result in compelling the buyer to pay a higher cost per ton for coal.
6. There are certain cases (notably in municipalities) where the payment of a bonus or premium is prohibited by charter or other legislative restraint.

It seems better therefore, if the same or better results can be obtained in some other way, to avoid the complexity of the combined bonus and penalty system. The procedure as followed by the Department of Water Supply, Gas and Electricity for New York City is herein outlined and may be applied with slight modifications to meet any other case:

Before drawing up definite specifications a careful investigation was first made of the character of the various coals furnished in the buyer's area, and from these results a diagram was plotted as respects the moisture, ash, volatile sulphur and combustible matter, and any coals falling within the limits so outlined were put in the list of eligibles as to quality, or as not open to a penalty. Coals lying outside these limits and below them would be penalized with respect to weight but not as to price, so that the buyer should not buy water or incombustible mineral matter and pay for them at the rate agreed on for good coal. The research developed the relation that each percentage of ash in the coal besides displacing 1 per cent. of combustible matter, had a retarding effect varying with the quality of the coal, equivalent to a withdrawal of between 145 and 155 B.t.u. with an average of 150 B.t.u. With this as a basis a formula was evolved applicable both to anthracite and bituminous coal in the following form:

$$\text{Corrected tonnage} = \text{tonnage delivered} \times \left(\frac{\text{B.t.u. per pound as delivered} - 150\ \text{B.t.u.} \times \text{excess percentage of ash}}{\text{B.t.u. per pound as specified in standard analysis}}\right)$$

For practical purposes the formula can be simplified by using a direct percentage relation whereby 1 per cent. in weight shall be deducted for each 100 B.t.u. and an additional 1 per cent. for each percentage of ash. This can be equally well applied when it is desired to give a bonus. There are advantages in separating the deduction for ash into two halves as above.

The Sampling of Coal for Analysis

Standard specifications should require that coal be analyzed in a laboratory; the analysis to be made on a sample representative of the entire delivery.

Inspectors or samplers should usually be designated to check the weighing.

Two distinct cases arise in getting samples: First, for lots of over 25 tons and less than 100 tons the sample should be 200 lb.; second, for lots of over 100 tons the sample should be approximately one ton in each thousand tons, or one-tenth of 1 per cent. of the gross quantity.

If the sample is taken from a pile, take the shovelfuls from all parts of the pile, care being taken to secure equal amounts from the top, the middle and the bottom of the pile. The gross sample taken by this method should contain the same proportion of lump and fine coal as exists in the whole shipment. In order to avoid gain or loss, it should be protected from the weather by being placed in a receptacle of sufficient size and having a cover, unless the gross sample can immediately be quartered down to a small sample. If the coal is larger than pea size it should be broken by hand or by passing through a crusher to approximate the pea size of coal which will pass over a ¼-in. square mesh without going through, and will pass through a square mesh of ½-in. clear opening.

After being reduced to a standard size the coal should be thoroughly mixed by shoveling it over and over and forming it into a conical pile. The pile should then be quartered; the two opposite quarters should be rejected and the remaining two broken down to a smaller size, mixed and reformed into a similar conical pile and quartered again. This process should be continued until the

lumps are ¼ in. in size or smaller, corresponding to buckwheat No. 2, which passes over a $\frac{3}{16}$-in. mesh without falling through and passes through a ¼-in. square opening, and the sample has been reduced to what will go into a 2-qt. can or to a quantity not less than 5 lb. in weight.

The sample should be worked down as rapidly as possible to avoid change in the percentage of moisture through exposure to the air, and then be inclosed in a can fitted with a lid which screws on tightly.

Analysis of Coal

The acceptability of coal supplied under contract should be determined by a standard chemical analysis. The same analysis should determine the weights to be used in computing the amounts to be certified in the audit of the bills. The laboratory analysis serial number should be filled in upon the coal-delivery report which accompanies each sample of coal, and the serial number of the coal-delivery report should be entered upon the analysis report, so as to avoid errors. The analysis report should embody all the information contained in the coal-delivery report and in addition the following data:

Date on which sample was received at the laboratory.

The laboratory serial analysis number.

The details of the analysis, together with the specifications of the standard in regard to each constituent, and the excess of deficiency disclosed by the analysis as respects the percentage of moisture in the coal at the point of weighing, the percentage of ash in dry coal, the percentage of volatile combustible matter in the dry coal, the percentage of volatile sulphur in the dry coal, and the heat value in B.t.u. per pound of dry coal.

The same data which are covered in the foregoing list of the coal-analysis report should also be entered upon the back of the coal-delivery report.

The coal-analysis report and the coal-delivery report blanks when the entries have been completed thereon should be transmitted to the parties interested, usually one copy to the contractor, one to the chief engineer and one to the office of the company.

In addition to the provision to prevent excess of clinker, analyses should be made at proper intervals of the ash rejected from the boiler furnaces to determine the proportion of combustible going to waste.

Determination of Price

The ultimate purpose of the analysis is to test the compliance of the coal actually delivered with the terms of a standard analysis given in the specifications. The accompanying table shows the standard analysis as required by the Department of Water Supply, Gas and Electricity.

The weight of coal as certified by the inspector and reported by him to the contractor is corrected when shown by analysis to be inferior to the standard, as follows:

The weight is reduced from that given by the weighing at the point of delivery by the percentage in excess of the standard which the analysis shows.

The weight of the coal after correction for moisture is then reduced at the rate of 1 per cent. for each percentage of ash in excess of that permitted by the standard, and the gross dry weight after correction for moisture at the rate of 1 per cent. for each 100 B.t.u. below the standard heating value. The gross dry weight is corrected at the rate of 5 per cent. for each 1 per cent. of volatile sulphur in excess of the standard. These corrections are then aggregated and deducted as a whole, payment being made only for the balance of the gross weight at the price bid per unit furnished, delivered and stored and trimmed (if so specified in the schedule).

Procedure Relating to Coal Contracts

The procedure to procure coal will vary widely according to condition. The complicated procedure under the departmental standard contract and standard specifications of the city of New York is as follows:

1. A schedule in standard form is filled out and signed by the mechanical engineer of the borough, if there be one. If there is no mechanical engineer, then by the operating engineer or the borough engineer.

2. This schedule must then be signed in succession by the borough engineer, the chief engineer or his deputy, the deputy commissioner (except in the

STANDARD ANALYSES—ANTHRACITE COAL

Sizes of Coal	Moisture, Per Cent. as Delivered	Ash, Per Cent. Dry Coal	Volatile Combustible Matter, Per Cent. Dry Coal	Volatile Sulphur, Per Cent. Dry Coal	B.t.u., per Pound Dry Coal
Broken	4	11	8	1.5	13,200
Egg	4	11	8	1.5	13,200
Stove	4	12	8	1.5	13,000
Nut	4	12	8	1.5	13,000
Pea	5	17	8	1.5	12,300
Buckwheat No. 1	6	18	8	1.5	12,200
Buckwheat No. 2	6	19	8	1.5	12,100
Buckwheat No. 3	6	19	8	1.5	12,000

STANDARD ANALYSES—SEMI-BITUMINOUS COAL

Run-of-mine	3.0	10	25	1.75	13,800
Lump	2.5	9	25	1.5	14,000
Nut	2.5	9	25	1.5	14,000
Slack	3.0	11	25	1.75	13,600

THE CITY OF NEW YORK
DEPARTMENT OF WATER SUPPLY, GAS AND ELECTRICITY
ENGINEERING BUREAU

STATION No._____ REPORT No._____

STATION_____ MONTHLY REPORT—PUMPING STATIONS _____ MONTH ENDING _____ 191_

SUMMARY OF RECORDS FROM DAILY REPORTS												EFFICIENCY RECORDS					SUPPLIES USED				
Day of Month	No. IN USE: Boilers	No. IN USE: Engines	Services in use R, T, C, D-S.	FEED WATER: Cubic Feet to Boilers in 24 Hours	FEED WATER: Average Temp. Deg. F.	Auxil's Running No. in Use Multiplied by No. of Hrs.	Mixture of Coal and Sizes	Coal Burned in 24 Hours Pounds	Water Pumped in 24 Hours Gallons	Total Lift Feet	Million Gallons Raised One Foot High	Gallons Raised One Foot High Per Pound of Coal	HORSE POWER: Total of Water Cylinders Per Minute	HORSE POWER: Total I. P. Per Pound of Coal Per Hr.	Total Heat of Steam at Boiler Pressure	Equivalent Evaporation From and At 212° Fahr. Per Pound of Coal	Cylinder Oil in Gallons	Engine Oil in Gallons	Grease in Pounds	Waste in Pounds	Out-door Temperature at 8 A.M.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
							(65). Previous Local Efficiency Standards to be Surpassed, via:														
1							Thirty One Lines in this Space One of each Day of the Month														
2																					
31																					

33 Total Coal Burned in Pounds — 36 Average of Column 13
34 Total Gallons Pumped per Month — 37 Average of Column 15
35 Total Million Gallons Raised One Foot — 38 Average of Column 17

Engineman-in-Charge.

MONTHLY REPORT OF PUMPING STATIONS

Borough of Manhattan) and the deputy and acting commissioner.

3. The schedule must specify: The quantities of coal; names and sizes of coal; points of delivery; quantities of installment deliveries; times of installment deliveries; method of weighing; unit prices, and total price.

4. It then passes to the bureau of supplies as a schedule to be incorporated into a standard form of contract. The steps in the bureau of supplies include: Revision by the contract clerk; revision by the corporation counsel; printing and correction of proof; copies to the commissioner when ready for advertisement; public advertisement; blank forms of contract issued; bids opened and tabulated; acceptance of bid recommended; advice of award sent to the comptroller; approval of sureties on the bid; execution of the contract, and notice to proceed under the contract.

Maintenance of Supply at Stations and Ordering under Existing Contracts

The coal supply and its adequacy at each station in a group of conditions such as prevail in a municipality is a matter of such vital importance that a double system of checks is considered advisable and is provided in the following:

The procedure in the case of new contracts is as stated in the foregoing section. After approval has been given, it is forwarded to the bureau of supplies for action in the contract division. After the award of the contract, the stores-control office makes the proper entries concerning kinds, prices, quantities and points of delivery, and issues the order to the contractor. Duplicates of this order are sent to the borough engineer's office and to the engineer in charge of the station which is to be supplied.

In the stores-control office a separate coal record is kept of the coal stored at each point and storage under each contract, covering quantities and kinds together with the records of analysis and corrected weights. When existing contracts are about to expire, the mechanical engineer of the borough, or, in his absence, the borough engineer, is held responsible for a notice to the chief engineer as to the need of fuel. The notice must be given in due time or when the station still has a four months' supply on hand.

The daily report of each pumping station is kept in duplicate, and contains the record of the total weight of coal of each class burned that day. The original report is mailed each day to the borough engineer, and after receiving his signature it passes to the supervising mechanical engineer for filing and preservation. A duplicate is sent to the statistical division of the department.

Whenever the balance of coal on hand at any station draws near to the minimum stock limit, the coal clerk at once reports the fact to the supervisor of stores, who in turn notifies the chief engineer.

The station man also, noting the same approach to a minimum stock limit, informs the borough engineer who issues the necessary order through the bureau of supplies for the delivery of more coal under existing contracts.

The Standard Records

Records are kept at the central office respecting the delivery, receipt and consumption of coal and the costs of generating power from such fuel. This is a function of the stores division. These records are kept on standard forms and include: the coal-scale weight book, the coal-delivery receipt, the coal-delivery report, the coal-analysis report, the coal-delivery record sheet, the coal-consumption record sheet, and the coal-audit report.

Tests

The coal called for by the standard uniform specifications may not be the best for every boiler furnace as they have been hitherto designed. The area of grate and type of grate and bar may need to be changed; the method of firing and thickness of fire may be improvable for a given fuel or mixture; the chimney draft may not be adjusted to the fuel and air spaces of the grates, and other conditions may need modifying. There is, therefore, room and need for practical tests by the engineers of the department, and these are made continually and at intervals to secure improvement.

Coal Consumption and Comparisons of Fuel Economy

The daily report of performance at the pumping stations, as now in use, gives the actual coal burned that day, and the weight or million gallons of water raised 1 ft. high by the combustion of this weight of coal at the station.

The monthly report totalizes the weight of coal burned during the month and the million gallons raised 1 ft. by the combustion of the monthly total of coal burned.

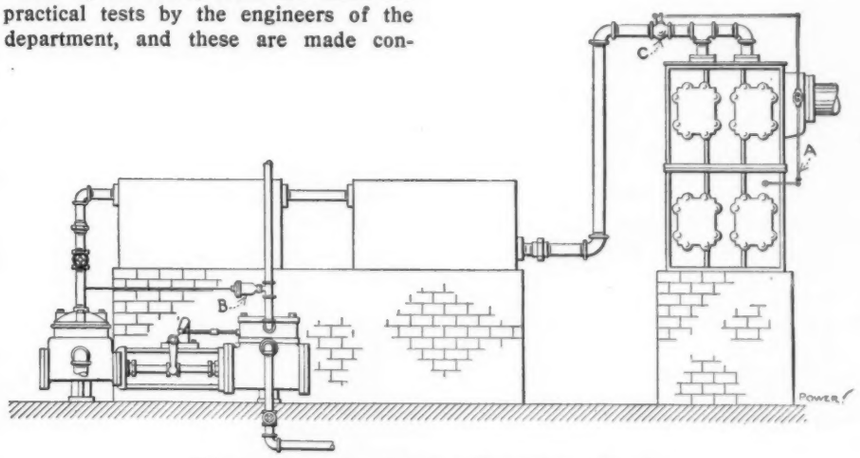
The daily and monthly reports have also been so planned as to give a continuous daily advice on the reduction of the coal supply at each station, and to eliminate any danger of exhaustion of the coal supply at any station if the blanks and the information they give are properly utilized.

Automatically Governed Feed Water Pump

A homemade arrangement for governing the speed of a service pump is shown in the accompanying illustration. The pump takes water from a river and after forcing it through two tank feed-water heaters, discharges it into an open feed-water heater from which it is taken by a boiler-feed pump and forced into the boilers.

To maintain a proper level in the open feed-water heater a back-pressure valve was placed in the inlet pipe and attached to the float of the heater, as shown at *A*. From the water end of the pump a ¼-inch pipe connection was made to a diaphragm control valve which was placed in the pump steam-pipe line, as shown at *B*.

The feed water is heated by the exhaust steam from the auxiliaries in the plant. When the water in the open heater gets to a predetermined hight, the float lifts, which closes the back-pressure valve *C*, until a back pressure of 10 pounds has been placed on the system back to the water end of the pump. This pressure is exerted on the diaphragm of the valve *B*, which closes the valve, thus slowing down the pump.



Home-made Governor for Feed-water Pumps

That the pump may not stop entirely and for convenience, a small ¼-inch pipe is run to the wash room, where the water runs continuously. By this arrangement the feed pump is running the 24 hours and the water in the heater is maintained at a practically constant hight.

Tests of Old Boilers

By Alex M. Gow*

Three return-tubular boilers 30 years old tested to destruction under hydrostatic pressure. In each the weakest point proved to be the manhole frame.

*Assistant chief engineer, Oliver Iron Mining Co., Duluth, Minn.

On June 6 and 7, 1911, three horizontal tubular boilers, designated as Nos. 301, 302 and 303, were tested to destruction with hydraulic pressure at Ishpeming, Mich. The boilers were owned by the Oliver Iron Mining Co. and had been in operation for about 30 years at No. 1 Hard Ore Boiler House, Lake Superior Mines. The boilers had been condemned on account of their age by the Hartford Steam Boiler Inspection & Insurance Co. as an unsafe risk, although they showed no signs of deterioration from their 30 years' service—there being no evidence of pitting or corrosion.

Inasmuch as it will probably be necessary to maintain a boiler plant for the next 20 years at the location where these boilers have been, it was decided to install new boilers and test the old ones to destruction to determine whether they were unfit for service, and whether any deterioration of any kind had taken place which was not in evidence from an external and internal inspection.

The three boilers were identical in construction with the exception that boiler 302 contained 112 three-in. tubes, while boilers 301 and 303 each contained 83 four-in. tubes. The accompanying drawing, Fig. 1, shows the construction of the boilers. It will be observed that each boiler consists of five courses of ⅜-in. sheets, double lap-riveted with ¾-in. rivets, spaced on 2-in. centers.

Pressure was obtained from a hand pump capable of producing a pressure of 300 lb., and, in addition, the pump of a hydraulic wheel-press was connected to the water line for additional pressure as required.

To determine the expansion of the shell, a steel tape was passed around the boiler and the movement of the tape was observed to determine the increase in circumference of the shell. Attempts were also made to determine the diametrical expansion with a micrometer gage set against the side of the boiler, but the observations on this gage were not satisfactory. The measurements upon the steel tape, however, were fairly accurate.

Boiler No. 302

This boiler was built about 1877 by Kendall & Roberts, of Boston. The sheets bore the brand "Bay State Homo." The accompanying log of the test, made June 6, 1911, gives in detail the behavior of the boiler under the successive pressures to which it was subjected.

At 275 lb. pressure, the cast-iron manhole frame broke in two with a loud report and the sheets were ruptured as shown in Fig. 2. At the time of the rupture, the steel tape showed that the circumference of the boiler had elongated approximately $\frac{3}{16}$ in. After the rupture the tape resumed its initial position, indicating that at 275 lb. pressure the shell had taken no permanent set. While there had been some leaking of longitudinal seams, there was no evidence of serious distress at any part of the boiler. The heads showed no sign of bulging and the tube ends remained tight.

TABLE 1. LOG OF TEST, BOILER NO. 302

Time	Pressure, Lb. per Sq.In.	Observations
10:12		
10:14	60	
10:15	93	
10:18	100	
10:18½	125	$\frac{1}{16}$-in. elongation in circumference
10:20	140	
10:20¼	170	
10:21	180	Seams weeping slightly
10:21¼	195	
10:22	200	$\frac{3}{32}$-in. elongation in circumference
10:22½	210	
10:24¼	220	
10:25	230	$\frac{3}{16}$-in. elongation in circumference
10:25¼	240	All longitudinal seams leaking
10:27½	250	
10:28	260	
10:28¼	275	Manhole frame broken

Test pieces cut from the shell immediately over the fire showed an average tensile strength of 60,460 lb., with 22.5 per cent. elongation, 53.7 per cent. reduction in area and an elastic limit of 36,690 lb. The analysis of this sheet showed: Carbon, 0.13; sulphur, 0.026; phosphorus, 0.097; manganese, 0.27. The test pieces were cut both transversely and longitudinally of the sheet, but it was impossible to tell from the way the test pieces broke in which way the sheet had been rolled. It is very evident that there had been no deterioration of the steel in this sheet. Test pieces were also taken from a sheet at the top of the boiler, where it was not subjected to the action of the fire. These test pieces gave an average of 70,145 lb. tensile strength, with an elongation of 20.12 per cent., an elastic limit of 39,060 lb. and a reduction of area of 47.05 per cent.

In addition to the test pieces cut from the sheets as mentioned, a section was taken out of the longitudinal seam. Upon being pulled in the testing machine, the joint gave an efficiency of 60 per cent. of the plate, breaking through the rivet holes. This seam showed no evidence whatever of deterioration and was as good as the day it was laid up. Subjected to cold bending tests, the test pieces from the sheets above the fire bent to 180 deg., flat, without fracture.

Boiler No. 303

Boiler No. 303 was built about 1879 by Kendall & Roberts, of Boston. The sheets bore the inscription "Nashua Iron & Steel Co., Nashua, N. H.," and an encircled Indian head, and were stamped "cast steel, 60,000 lbs." Inasmuch as this boiler was identical in construction with boiler No. 302, which had developed its weak point in the manhole frame, and as it was desired to put a greater pressure on the boiler than the manhole could stand, it was decided to remove the frame and put on a ⅝-in. patch, secured by patch bolts, in place of the cast-iron frame.

On the morning of June 7, pressure was applied to the boiler in the same manner as to boiler No. 302 the day before. The log shown in Table 2 gives the observations in detail:

TABLE 2. LOG OF TEST, BOILER NO. 303

Time	Pressure, Lb. per Sq.In.	Observation
10:00	15	
10:01¼	20	
10:01½	30	
10:03	90	
10:03¼	110	$\frac{1}{16}$-in. elongation in circumference
10:05	150	
10:05¼	160	Seams begin to weep
10:06	170	
10:06½	180	$\frac{3}{32}$-in. elongation in circumference
10:07½	220	
10:08	225	⅛-in. elongation in circumference
10:08½	240	One girth seam leaking.
10:09½	250	$\frac{5}{32}$-in. elongation in circumference
10:11	270	
10:11½	275	$\frac{3}{16}$-in. elongation in circumference
10:12½	280	
10:13	285	$\frac{7}{32}$-in. elongation in circumference; tubes beginning to leak
10:15	295	
10:16½	297	Could obtain no more pressure by hand pump; pressure let down and hydraulic pump cut in. Boiler resumed its normal diameter; no permanent set
10:25	175	
10:26	195	$\frac{1}{16}$-in. elongation in circumference
10:27½	255	
10:28½	275	
10:28¾	295	
10:29	300	$\frac{5}{32}$-in. elongation in circumference
10:30	300	Seams leaking badly and some leaking at the ends. Stopped pumping to calk one patch bolt and tighten one plug
10:34	...	Pressure let down
10:45	...	Started pumps again
10:46	125	
10:46½	145	Stopped pump to roll one tube
10:53	145	
10:55	160	$\frac{1}{32}$-in. increase in circumference
10:55½	180	
10:55¾	210	$\frac{1}{16}$-in. increase in circumference
10:56	230	
10:56½	50	$\frac{3}{32}$-in. increase in circumference

10:56¾	270	
10:57	...	⅛-in. increase in circumference
10:57¼	285	
10:57½	295	Tubes leaking. Head shows signs of distress
10:58	300	Beading on tubes is sprung
10:59½	295	⅞-in. increase in circumference
11:00	300	13 patch bolts sheared

At 300 lb. pressure the patch and one plug began leaking so badly that the pumps could not gain, and it was necessary to reduce the pressure and calk the leaks. At 10:45 the pressure was again applied and upon obtaining 300 lb., there was noticeable distress on one head, with leaking of tubes and springing of the beading. The steel tape indicated that the boiler was increasing in diameter. The leaks were such that the two pumps were not able to gain over 300 lb. pressure, and at this pressure 13 of the patch bolts sheared. The manhole sheet expanded approximately ½ in. with no rupture. It being impossible to replace the patch, and the head having shown evident distress, no further attempt was made to burst the longitudinal seams. The steel tape showed that the boiler had expanded about 1/16 in., and it did not resume its normal diameter.

Test pieces cut from the sheet immediately over the fire showed a tensile strength of 60,186 lb.; elastic limit, 38,280 lb.; elongation, 21.5 per cent., with 54.52 per cent. reduction of area. Analysis of the steel gave: Carbon, 0.17; sulphur, 0.023; phosphorus, 0.097; manganese, 0.29. Test pieces cut from the sheet at the top of the boiler showed a tensile strength of 56,400 lb.; elastic limit of 37,230 lb., and an elongation of 27.25 per cent., with 64.88 per cent. reduction of area. Analysis of this steel showed: Carbon, 0.25; sulphur, 0.021; phosphorus, 0.092; manganese, 0.37.

Boiler No. 301

Boiler No. 301 was identical in construction with boiler No. 303. It was purchased at the same time and the sheets bore the same brand. It was tested in the same manner, and the log of the tests in Table 3 shows the observations:

At 260 lb. pressure the manhole casting broke in identically the same manner as that upon boiler No. 302, first tested. The steel tape, however, showed that the boiler had taken a permanent set of ⅛-in. elongation in the circumference, probably due to slight movement of the longitudinal seams, which showed signs of distress.

Test pieces taken from a sheet immediately over the fire showed a tensile strength of 60,780 lb.; elastic limit, 33,100 lb.; elongation, 26.5 per cent.; reduction of area, 61.62 per cent. Analysis as follows: Carbon, 0.13; sulphur, 0.022; phosphorus, 0.105; manganese, 0.20. Test pieces taken from the top of the shell, not subjected to the fire, showed a tensile strength of 61,680 lb.; elastic limit of 38,820 lb.; elongation, 19.75 per cent., and a reduction in area of 50.80 per cent. Analysis as follows: Carbon, 0.18; sulphur, 0.022; phosphorus, 0.085; manganese, 0.28.

The tests for tensile strength and the chemical analyses were made at the works of the Illinois Steel Co., South Chicago, through the courtesy of P. E. Carhart, inspecting engineer. Twelve test pieces were measured with a micrometer and showed a maximum thickness of sheet of 0.380 in.; minimum thickness, 0.364 in.; average, 0.373 in. This variation in thickness is no greater than would be expected in nominal ⅜-in. boiler plate, and showed that there had been no appreciable reduction of thickness by reason of corrosion on the surface of the plates.

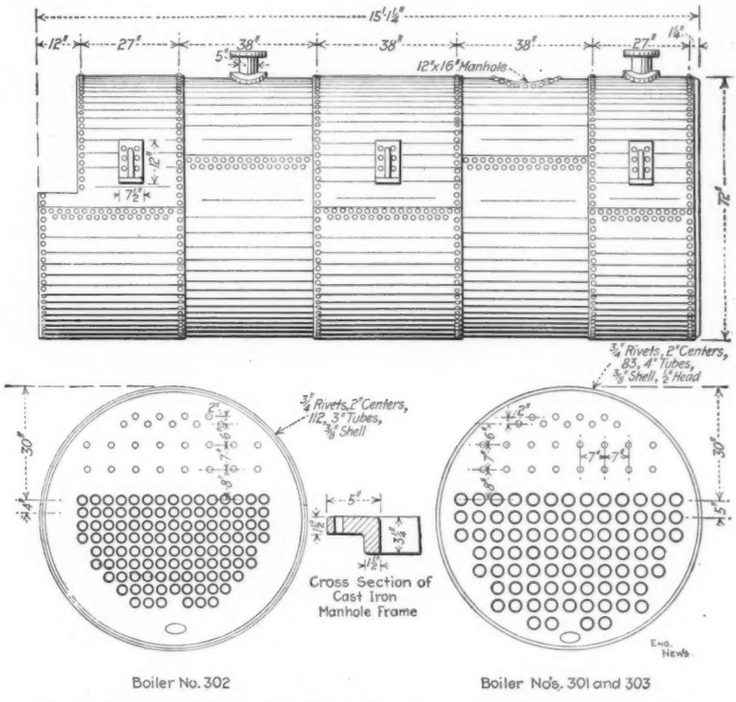


Fig. 1. Drawing Showing Construction of 30-Year Old Boilers Tested at Ishpeming, Mich.

Fig. 2. Photograph Showing Manhole Frame of Boiler 302 After Failure at 275-lb. Pressure

The boilers had been originally built to carry 100 lb. pressure, but inasmuch as, allowing the longitudinal seams an efficiency of 60 per cent. of the plate, this would give a safety factor of but 3.75, the working pressure had been fixed at 80 lb., giving a safety factor of 4.70. It is evident that the weak point of each boiler was the cast-iron manhole ring. Boiler No. 301 broke at this point at a pressure of 260 lb. With the pressure of 80 lb., the safety factor at this point was, therefore, but 3.25.

Had this cast-iron manhole ring broken in service it is not probable that an explosion would have resulted. Fig. 2 shows a ruptured sheet from boiler No. 302. This rupture occurred when the manhole ring broke at a pressure of 275 lb. When the manhole ring on boiler No. 301 broke in identically the same manner, at a pressure of 260 lb., the sheet was not ruptured. Furthermore, when the patch bolts sheared at a pressure of 300 lb. on boiler No. 303, the

TABLE 3
LOG OF TEST, BOILER NO. 301, JUNE 7, 1911

Time	Pressure, Lb. per Sq.In.	Observation
11:15	...	Pump started
11:15½	55	
10:17	85	
10:17½	100	
10:18½	150	½-in. increase in circumference
10:20	155	
10:20½	180	Seams weeping
10:21	205	Flues leaking a little
10:21½	225	
10:22	235	Leaking at manhole
10:22½	250	⅝-in. increase in circumference
10:23½	255	
10:24	260	Manhole broke; ¼-i increase in circumference

sheet was not ruptured. It is fair, then, to assume that had a manhole ring let go in service at a pressure of from 80 to 100 lb., no rupture of the sheet or explosion of the boiler would have followed. But upon this point there is room for a difference of opinion.

SUMMARY

It is evident from the above tests that there had been no deterioration in the quality of the material, and it was such as would pass today for good boiler plate. The one sheet from the top of boiler No. 302, that had a tensile strength of 70,000 lb., showed slight cracks under the cold-bending test to 180 deg., flat. The fracture in every case was good and no one of the test pieces showed the slightest indication of lamination or lack of homogeneity.

All in all, the boilers were as good as the day they were made; the material was excellent, the workmanship was admirable and subject to only one criticism —the rivet holes had not been reamed. With this exception, the workmanship could not be improved upon. In no way, shape or form had the boilers deteriorated by the 30 years' service to which they had been subjected; the water furnished had been of uniformly good quality; they had received excellent care and attention. At times they had been fired very hard, sometimes with wood, sometimes with coal, at other times with a mixture of wood and coal.

It is interesting to note in this connection that the Bay State Iron Works, which made the steel for boiler No. 302, had, according to a list of rolling mills and steel works published in 1882, one 6-gross-ton Siemens openhearth steel furnace, with an annual capacity of 2800 net tons of ingots. The Nashua Iron & Steel Co., Nashua, N. H., had one 10-gross-ton Siemens openhearth steel furnace. These furnaces must have been among the earliest Siemens openhearth furnaces built in the United States, and these boilers among the very early ones built from such material.

Boiler Explodes at Knoxville, Tenn.

By John Mathie

Explosion of a locomotive type of boiler resulting in two deaths and several injured. The lower valve on the water gage was found closed and presumably the fireman had been running on a false water level. Also the safety valve was screwed all the way down.

The accompanying photographs show the remains of the boiler which exploded at the quarry of the Royal Marble Co., near Knoxville, Tenn., on Feb. 5, killing the fireman and his brother, who happened to be present at the time. The boiler was of the locomotive type, carried on skids and furnished steam to run rock drills at the quarry, five being in operation at the time of the explosion.

On Jan. 28, 1912, the boiler had been inspected by a well known insurance company and had been pronounced safe to carry 100 lb. pressure.

Fig. 1 is a general view of the quarry and the adjoining field after the explosion, showing (1) the location of the boiler house; (2) where the main portion of the boiler landed, 350 ft. from its original location; (3) where the front landed, 150 ft. in the opposite direction, and (4) the place at which the bodies of the fireman and his brother were found.

At one corner of the boiler house there stood an electric-light pole carrying two transformers. Both of these were destroyed, one being hurled a distance of 120 ft., and, in all, three poles were knocked down.

A man passing the boiler house at the time of the explosion was struck by a barrel used for supplying water to the boiler, and was carried a distance of 75 ft., where he dropped to the ground, while the barrel bounded 15 ft. farther, turned over and emptied. The man had one arm broken in two places, a leg broken and three ribs.

Fig. 2 shows the boiler in its final position, and Fig. 3 is a view of the front, showing how the crown-sheet tore from the stay-bolts and braces. This piece landed on several men working in the pit and more or less injured all of them. Fig. 4 is another view of the same piece.

FIG. 1. LOCATION MARKED 1 SHOWS WHERE BOILER ORIGINALLY STOOD; 2 SHOWS WHERE MAIN PART OF BOILER WAS HURLED; 3 WHERE FRONT OF BOILER WAS FOUND AND 4 WHERE THE BODIES OF THE FIREMAN AND HIS BROTHER WERE FOUND

Particular attention should be paid to Fig. 5, which shows the safety valve that was on the boiler. It will be observed, upon looking closely, that the valve had been screwed down until the coils of the spring were pressed one upon the other. This valve could not open under any pressure and instead of being a factor of safety it was, as it proved to be, a menace to life and property.

When tested with water at a pressure of 130 lb. per square inch after the explosion, not a drop came past the disk. This valve had been set at 100 lb. and the gage was tested on Jan. 28, 1912. Therefore the question is—Who screwed down the valve?

A fusible plug had been put in the boiler about one month before the explosion, and upon examination the fusible metal in the plug showed that it had melted, but the face of the plug in the boiler appeared to have been scaled over, thus preventing the metal from dropping. In view of this it would seem a good idea for all engineers who have fusible plugs in their boilers to scrape them until they show bright every time the boilers are cleaned.

Upon inquiry, the writer learned that the fireman had closed both valves on the water gage the night before the explosion and in the morning had only opened the top valve as the bottom valve was closed when found. This would indicate that he had run from 6 a.m. until 10:30 a.m., thinking the water shown in the glass was the true level.

National Coating

National Coating is a preparation which is supplied to piping ranging in sizes from 3 to 18½ in. outside diameter. Its purpose is to prevent external corrosion and electrolysis.

When a pipe is to be coated, it is first cleaned and dried and dipped in a special bath, and upon being dried is left with an inside and outside coating of an elastic compound. This enamel-like surface is wrapped with a strip of fabric which has also been thoroughly saturated in the hot compound. It is wound spirally over the surface of the pipe, about 1 in. on each turn. Two or three thicknesses may be applied in this way when desired to meet special conditions. The covering firmly adheres to the body coat of the pipe. The main purpose of this covering is to protect the pipe from moisture.

National Coating is manufactured by the National Tube Co., 1106 Frick Building, Pittsburg, Penn.

New Insulating Tape

The Westinghouse Electric & Manufacturing Co., Pittsburg, Penn., has recently placed on the market a bias-cut treated cloth tape which is made under a new process and for which some very satisfactory characteristics are claimed. It can be used as continuous tape, having a good tensile strength throughout its entire length, or may be divided into 4-ft. lengths by tearing, or without the use of any cutting tool. There are no sewed seams which, when present, have to be cut to make a neat job.

This tape also has the same dielectric strength throughout its length as the full-width treated cloth. It is also free from

FIG. 2. MAIN PART OF BOILER AFTER EXPLOSION

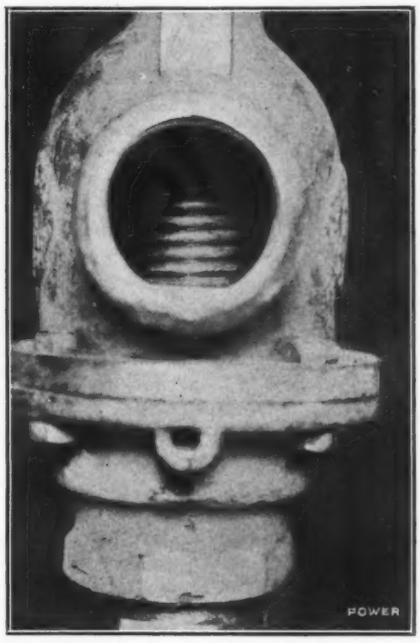


FIG. 5. SAFETY VALVE WITH SPRING ALL THE WAY DOWN

FIG. 3. FRONT OF BOILER

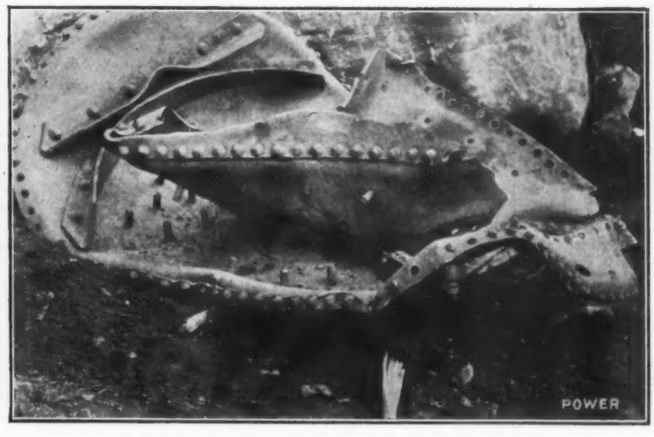


FIG. 4. SHOWING HOW CROWN SHEET TORE

uneven places due to the running of the insulating liquid which collects in the sewed seams during the process of treating.

This new process tape has also been specially designed to have the best possible amount of grip and slip; that is, it has a degree of tackiness that particularly adapts it for taping purposes.

Reinforcing Van Stone Joints

By W. N. Stevens

To those who have not analyzed the strains on a van stone joint, it may seem reasonable to assume that by reinforcing the metal in that portion of pipe flanged out to make the joint, additional strength is obtained. This, however, is not the case. Pipe is made from plates which are rolled from an ingot and bent over and welded. As the van stone joint is made while the metal is hot, it is not injured in being flanged out for the same reason that rolling does not injure the plates.

The illustration shows the approximate dimensions of a van stone joint on an 8-in. pipe. If the thickness of the flanged-out portion at *A* (1 in. from the bore) is 75 per cent. of the shell of the pipe at *B*, then there is exactly the same area of metal to resist tension at *A* as there is at *B*. As the flange has the same radius of curvature as the pipe, it is obvious that only a very small part of the tension at *B* can be transmitted around to *A*.

Van stone joints are made in a machine and consequently only a very thin cut is necessary to provide a steam-tight joint between the pipes, and when finished the area of the metal at *A* is rarely less than 80 per cent. of that at *B*. It should be borne in mind that this refers to the area of metal that resists fracture.

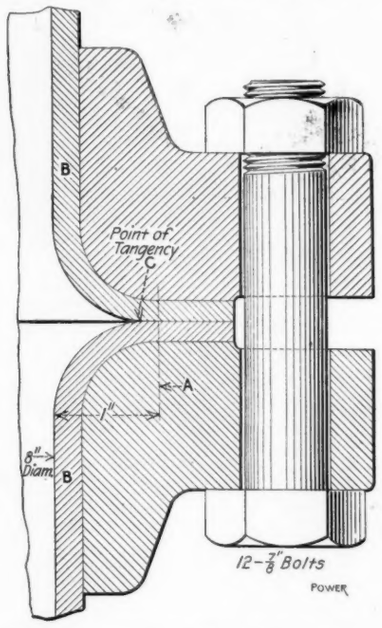
Assume, however, that the flanged-out part has been turned off until the area of metal at the point of tangency *C* is one-half that at *B*, also that bolts have been provided of sufficient strength to withstand the hydrostatic pressure required to break the pipe. As the pressure required to burst the pipe is 4000 lb. per square inch, assuming a tensile strength of 50,000 lb. per square inch, and the cross-sectional area within the pipe is 50 sq.in., there will be 200,000 lb. exerted along the pipe. The area of metal in the circular section at *B* is 8.4 sq.in. and the metal will therefore be under 24,000 lb. per square inch longitudinal stress. As assumed, there is only half the metal at *C*, and if all this stress could be transmitted to *C*, there would be 48,000 lb. per square inch tension at *C*, which is less than the bursting strain at *B*. The pipe would therefore burst before the joint would break, because it is impossible to transmit all the strain around the corner.

How, then, can reinforcing the flanged-over part add strength if the area of metal at *C* is one-half of that at *B*? In order to answer this, look at the matter from another point of view. The sectional area of metal in an 8-in. standard weight pipe is 8.4 sq.in. An extra-heavy 8-in. flange has twelve ⅞-in. bolts. The area of metal in a ⅞-in. bolt, at the bottom of the thread, is 0.42 sq.in. The area of the 12 bolts is

$$12 \times 0.42 = 5.04 \text{ sq.in.}$$

There is therefore 66 per cent. more metal in the shell of the pipe than in the bolts.

In order to make a tight joint the bolts must be screwed up hard, and they are under a considerable stress in addition to that transmitted to them by the pipe, and all of the stress in the pipe is transmitted to the bolts. It is impossible to estimate what this initial stress on the bolts will be, but the factor of safety of the bolts is rarely one-fourth as large as that of the pipe if the joints are tight.



Section through Van Stone Joint

From this point of view it is clear that nothing is gained by reinforcing the flanged-out part of the pipe, as the bolts cannot hold one-fourth the pressure necessary to burst the pipe.

The foregoing figures have been based on an 8-in. pipe, but it will be found that the other sizes will lead to the same conclusions.

While it is very desirable to improve van stone joints and incidentally the joints between fittings in high-pressure steam piping, this discussion shows that improvements must begin at the weakest point to have any value whatever, and the weakest points are the bolts.

To bring the factor of safety of the bolts up to that of the flanged-over portion of the pipe in a van stone joint, even after half of the metal has been turned off, at least four times as much metal should be put in the bolts.

Actuating Forces in Straight Line Air Compressors

By Frank Richards

The questions which have recently been current in the pages of Power as to the direction in which the crankshaft of a straight-line air compressor should run, and also as to the peculiar knocks sometimes accompanying the crosshead movements in compressors of this type, suggest the following analysis toward a clear and final understanding of the matter:

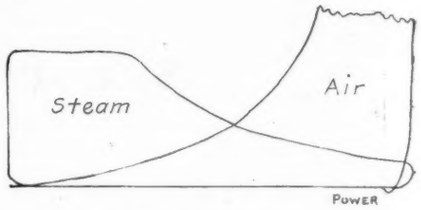


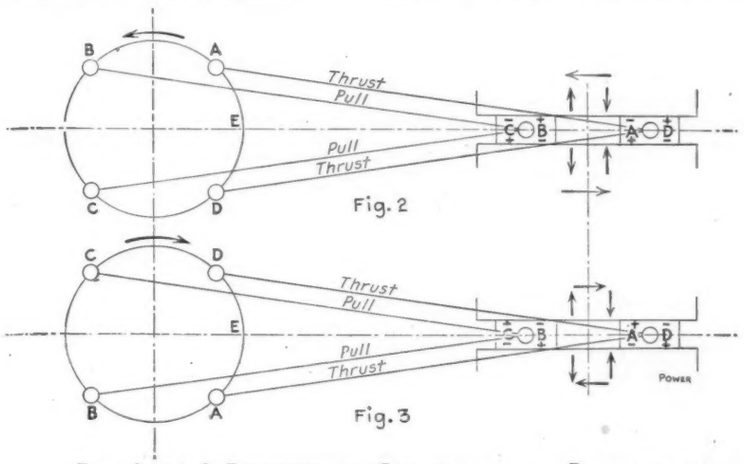
Fig. 1. Combined Air and Steam Diagram

It is well known that in the horizontal steam engine, if the crankshaft runs over, the crosshead pressure is always downward; while if the crankshaft runs under, the resultant vertical forces at the crosshead are reversed, and are usually more than sufficient throughout the stroke to overcome the weight. In the air compressor the conditions are very different, no matter which way it runs.

Consider the typical combined air and steam diagram, Fig. 1, which might be from any straight-line compressor, the cylinders being assumed to be of equal diameter. In the earlier portion of the stroke the steam pressure is greatly in excess of the air resistance, and the surplus of power must be disposed of in increasing the momentum of the flywheel. At the point where the steam-expansion line and the air-compression lines cross, the pressure in the steam cylinder just equals the resistance in the air cylinder, and beyond that point to the end of the stroke the steam pressure must be assisted by the momentum of the flywheel. The inadequacy of the steam to maintain the running really begins before the point is reached where the lines cross, because there is the entire friction of the machine to be overcome and the running speed to be maintained, so that the actual reversal of the balance of the driving forces occurs very near midstroke, no matter in which direction the crankshaft turns.

The story of what happens is told graphically in Figs. 2 and 3, and it would seem that little explanation is required. In Fig. 2 the shaft runs over and in Fig.

3 it runs under. At the crosshead the + sign indicates that it is pressing against the guide while the — sign indicates the reverse. The vertical arrows at each side of the midstroke line indicate the direction of the vertical thrust of the crosshead for that portion of the stroke. The horizontal arrows indicate the direction of the travel of the crosshead.



FIGS. 2 AND 3. REPRESENTING GRAPHICALLY THE PRESSURES ON THE CROSSHEAD AND PIN

It will be seen that there is but one reversal (and back again) of the connecting-rod stress for the revolution. Running in either direction, there is a thrust for about one-half of the revolution and a pull for the other half. The crosshead, however, shows four consecutive reversals of vertical thrust for each revolution. If there is any conclusive reason why the crankshaft should turn in one direction in preference to the other, the writer has failed to discover it.

Taking Measurements for Plans

BY A. E. DIXON

It looks easy to measure up something, a building, for instance, so you can make a plan of it. It is not so difficult either, but it is an easy thing to fall down. The falling down comes from forgetting to take some essential dimension more than from any other cause. This is particularly aggravating when one has to travel any distance to obtain the missing information. In this kind of work it does not pay to trust to the memory; a memorandum sketch will prevent one from removing surplus hair by the diligent scratching which accompanies the effort to stimulate the brain into recalling details.

The sketch in Fig. 1 shows the field measurements taken in preparing a plan of an engine room. These measurements were taken with a 100-foot steel tape graduated in feet, inches and eighths of an inch. One corner of the building was taken as a base and the tape was used to obtain the distance from this corner to the side of every opening and projection on the wall. A sketch plan was first made. This plan was exactly like Fig. 1—in fact, it was Fig. 1, without any of the dimensions. There was no effort to work to scale, the sketch being made to show only the features of which the location was required with ample space to add the dimensions. The projection of the pilasters was measured at several points and the thickness of the wall was taken at several of the openings, the average being used. These dimensions tie the external and the internal dimension together. In actual cases it is rare for the measurements to balance up as neatly as those given on the sketch, owing to the small unavoidable errors of workmanship which occur in building construction. There is an ancient saw that a mason's eighth of an inch is the thickness of the handle of his "sword" (trowel); therefore, provided these dimensions agree with reasonable margins, they can be assumed as correct. Window frames are frequently set and bricked and may vary an inch or two in location.

In locating the engine two sides of the room are used as base lines and the center lines of the piston rods and the shaft are located. The engine may be slightly out of square with the room; in fact, the room itself may be out of square. This can be tested by running

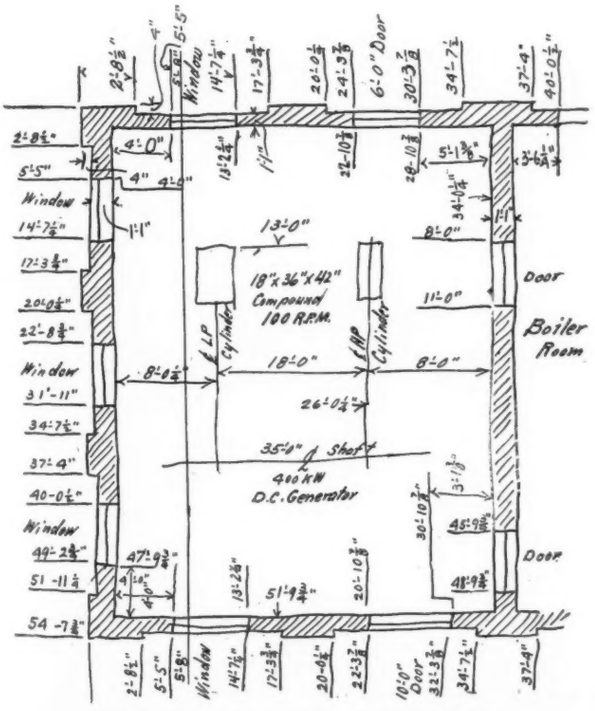


FIG. 1. FIELD SKETCH OF ENGINE HOUSE

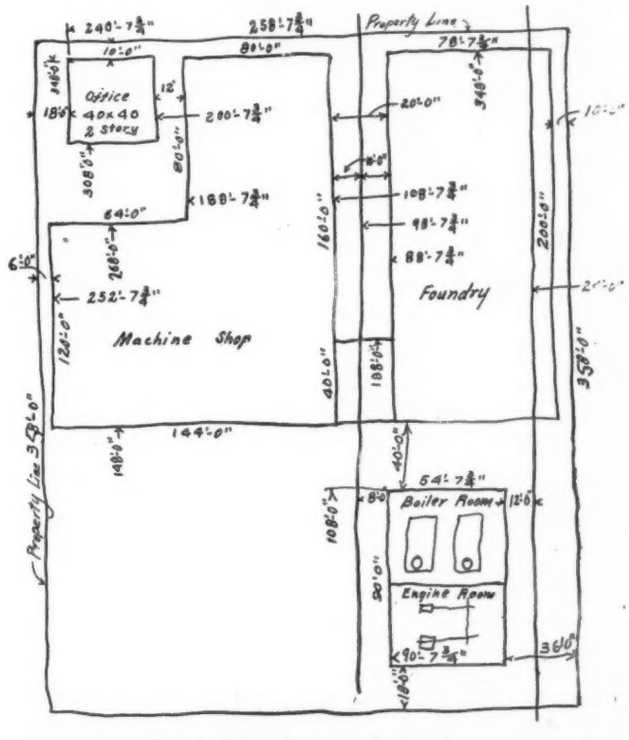


FIG. 2. FIELD PLAN OF PLANT LAYOUT

a line through the room and extending out through two opposite windows. This line should then be carefully located with reference to two corners of the building. A fine wire stretched tight makes the best sort of a line. The distance from this line to the wall should then be carefully noted at a number of points.

The next problem is to locate another line at right angles with the first. This can be done by transferring the original line to the floor by the aid of plumb bobs; a right-angled triangle is then laid off, and the second line located in this manner is used to check up the other walls.

The laying out of a right-angled triangle is not difficult. Any triangle whose sides are in the ratio of 3, 4 and 5 includes one right angle, that made by the sides 3 and 4. The length of the sides is not important, but the ratio is, and the bigger the triangle the more accurately it can be laid out. That is, a small error in laying out this triangle when the sides are 30, 40 and 50 feet long leads to a smaller percentage of error in the final result than the same error in the sides of a triangle whose dimensions are 3, 4 and 5 feet.

When it is desired to locate the building measured up with reference to other buildings or by the property lines, similar means can be adopted as illustrated in the sketch in Fig. 2, which is supposed to illustrate the plant layout. The property lines at the right and at the bottom have been taken as base lines from which all of the buildings have been located.

In making elevations it is a good plan to take the main-floor level as elevation + 100 feet and use this as the third reference plane. Where a Government bench mark is available a permanent bench can be made on the property and tied in with the Government bench mark by a surveyor. When a Government bench is not available the railroad whose spur connects with the plant can supply levels covering its track and a bench mark can be laid off from this. The assuming of elevation 100 for the bench mark will avoid all negative elevations in cellars and pits.

Cylinder Head Blew Off

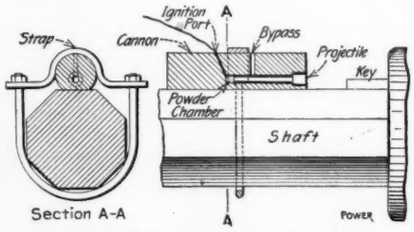
On Feb. 7 a cylinder head of a lighting engine in the Hotel Jermyn, Scranton, Penn., blew off and injured three employees. These men had been detailed to examine the cylinder. They closed the throttle valve, also the drip valves, took all the nuts off the studs and then after a light tap with a wrench or hammer the cover suddenly blew off.

It seems that the throttle leaked badly and soon filled the cylinder with steam and water. With the drips and exhaust closed there was no chance for its escape and taking all the nuts off the studs before loosening the head allowed the steam to rush out and scald the men. Two of the men were badly scalded and were sent to the hospital. They will recover, however, and will probably be more careful next time they have a job like that to do. The third man was cared for in the hotel and continued his watch.

Shooting Out Keys

By R. D. Tomlinson

I am reminded by the article in the Jan. 30 issue of Power, telling of the use of dynamite for removing a pinion from a shaft, of an experience which I had some years ago when in charge of a machine shop. Our work was to keep in repair over forty steamboats used for towing purposes; also, the machinery in the street-railway power plant and several cement mills. It frequently happened that we were called upon to make quick repairs, and it would tax the ingenuity of our best men to know how to handle some of them.



Cannon for Shooting Out Keys

The company owned, in addition to the regular tugboats, some old side-wheel steamers which were very useful in towing; the engines had wooden frames. In one of them the frame would spring so badly that it was necessary to take off the cylinder top and turn off an inch on the inside in order to prevent the piston striking either the top or the bottom. If the engine was lined up before the coal was on board it would be way out of line as soon as she took on her cargo, and when it was lined up with all the coal on board, by the time the boat got to the end of the trip, the engine was way out of line. To remedy this we used to line up with about one-half the regular amount of coal on board.

One afternoon a large side-wheeler was towed into the dock with a broken shaft, the break being just inside of the wheel house, between the spring bearing and the hub for the first set of arms. These paddle wheels were made of wood, except the shaft and hub; the shaft, where it went through the hub, was octagon, and the hub was staked on with keys. As the boat ran down the river into salt water and the keys had been driven in many years before, they were badly corroded. It was impossible to start them with a sledge, there was no room to swing a ram, and at first it looked like tearing the wheel house all to pieces in order to get that shaft out.

Our superintendent made a suggestion which was at first somewhat startling, but after thinking it over, we concluded it was worth a trial, as it was a serious matter to tear down the entire wheel house in order to get at the job. His suggestion was to make a cannon and shoot the keys out.

We planed a piece of 6-in. steel flat on one side so that we could clamp it on to the shaft; then we bored the cannon about 1½ in. in diameter, turned up a steel projectile with a hardened end and drilled a hole down into the bore of the cannon at a point where the projectile would pass it at the time it struck the key, the object of which was to relieve the pressure in the cannon without shooting the projectile out of the gun. If we had done that, it would have been lost as the work had to be done over open water.

After we had the gun finished we took it out in the yard and shot at some marks, using ordinary biasting fuse to ignite the powder. Then we strapped the gun on to the shaft, loaded it up, put in about 4 ft. of fuse, which gave the man who lit it plenty of time to crawl out of the wheel house and get back of the engine room.

The first shot gave the key a heavy jar, but did not start it. We put in a little more powder next time, and were delighted with the result; the key had started about ⅛ in. We gave it one more shot and then drove it out with a sledge. It was an easy matter afterward to get the rest of the keys out.

This method of starting out rusty keys is somewhat unusual but very effective, and some engineer who reads this article may have a condition arise where he can get out of very serious trouble in the foregoing manner. It is advisable that the engineer who tries this scheme do a little experimenting with his gun before shooting out the keys to find out how much powder he needs, and use a fuse long enough for him to get out of the way. Guns have been known to burst, and the material he has at hand out of which to make his gun is not apt to be up to government specifications.

A proposition has been presented to the Ministry of Public Works for utilizing the rapids of the Salto Grande Falls in the Uruguay River, some 15 miles above the city of Salto, to generate electrical energy for transmission to towns on both banks of the river and ultimately to Buenos Aires and Montevideo. The project also includes the construction of navigable channels through the rapids and a plan for irrigation. The operations are to be commenced with a proposed capitalization of $12,000,000, and a concession for a term of 90 years.

Gas Power Department

Worth-while gas-engine and producer information treated in a way that can be of practical use

The Mathot Suction Producer

The reactions which take place in a gas producer, namely, the dissociation of steam for generating hydrogen, and of carbonic acid for producing carbon monoxide, as well as the generation of steam, are endothermic operations; that is, operations absorbing heat. It is, of course, essential, for good efficiency, to abstract the minimum possible heat from the burning fuel for performing these operations and also to recover the heat from the gas generated by utilizing it for evaporating water, or for superheating the steam and preheating the air required for combustion.

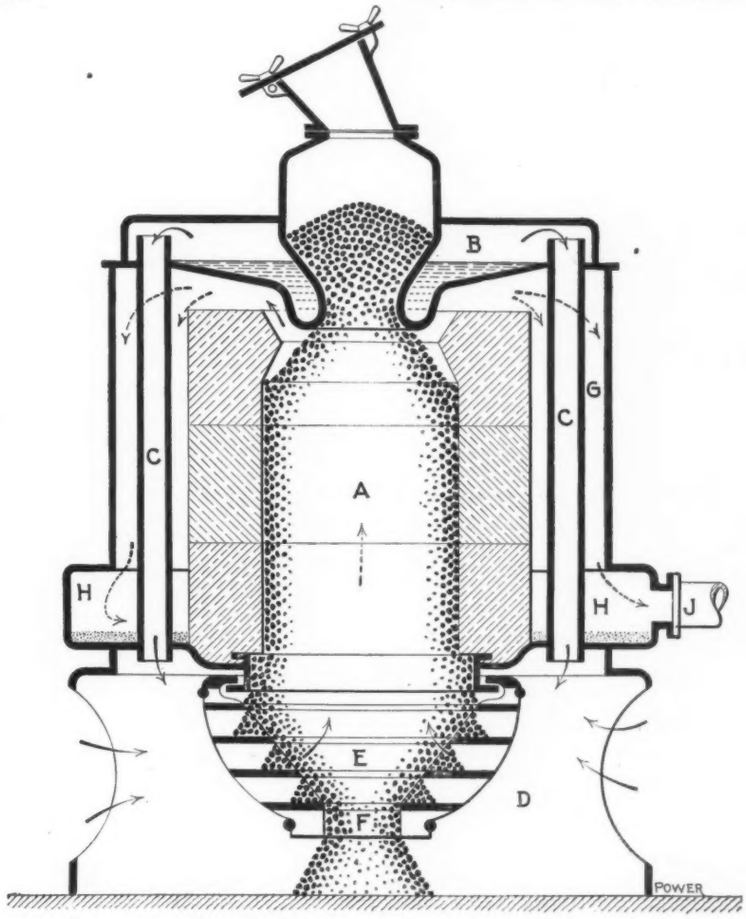
In certain producers the steam is generated in a compartment or vessel surrounding the lower part of the gas generator by means of part of the heat liberated by the combustion of the fuel. This process is detrimental to economy unless required for preventing formation of clinker when using certain coals.

In other cases, when working at reasonable loads, the gas leaves the outlet of an ordinary generator at a temperature ranging from 600 to 700 deg. F. and for cooling this gas before entering the engine a large amount of water is required in the scrubber (from three to four gallons per brake horsepower-hour). Consequently, much sensible heat is wasted which could be partly recovered and used to advantage in generating steam and assisting the endothermic conversions of the CO_2 and H_2O, at the same time reducing the quantity of water used in the scrubber.

The foregoing considerations have led Mr. R. E. Mathot, the well known Belgian engineer, to work out what he designates a recuperative producer. The construction of the generator is illustrated by the accompanying sectional drawing in which *A* is the fuel chamber, lined with brick and provided with the usual hopper; *B* is a water vaporizer; *C, C* are pipes by which the steam goes down from the vaporizer *B* to the ashpit *D; E* is a basket grate; *F* is an opening for depositing ash and clinker; *G* is a gas chamber surrounding the brick lining of the fuel chamber; *H* is a dust collector, and *J* is the gas outlet.

The grate is hung freely under the firebrick lining and is formed with a series of flat horizontal bars, stepped to from the "basket"; the fuel and ash rest both on the bars of the grate and on the heap formed under the opening *F*. Mr. Mathot states the distinctive features of the producer as follows:

The basket grate affords an area of air inlet about double the cross-section of the fuel bed and four times that of the free space between the bars of the ordinary flat grate. This, as well as the shape of the bars of the basket grate, Mr. Mathot states, allows burning any kind of low-grade coal of the smallest size without unduly restricting the air passage.



MATHOT'S SUCTION GAS GENERATOR

The steam being fed to the fuel independently of the air and the latter being always freely admitted in the open ashpit, the proportion of steam to air cannot be disturbed by cleaning out the ashpit; in the ordinary suction producer, opening the ashpit permits a large volume of air to get in without a corresponding increase in the steam, and the gas is impoverished.

The gas, instead of being withdrawn from the top, leaves the generator shell at the bottom after having passed around the brick lining for preventing external radiation of the heat of the combustion zone. In passing down to the exit, the gas gives up sensible heat to the steam, which is therefore superheated before reaching the fuel bed, allowing a greater quantity of steam to be dissociated without cooling down the fire. This, of course, gives a greater amount of hydrogen in the gas and a higher calorific value. Mr. Mathot informs us that some tests made with his producers have shown the following chemical composition and heat value compared to those of the ordinary type of suction producer:

	Ordinary Type	Mathot Producer
	%	%
CO_2	6	7
CO	23	24
H	15	22
N	52	49
B.t.u. per cubic foot	132	157

The ashpit being always open and the fire visible from the outside, supervision

and cleaning are possible at any time. The fire can be poked and the ash and clinker removed while the engine is at work without impairing the quality of the gas, since steam and air are always supplied in the same proportions.

In an ordinary producer a sudden dropping of incandescent matter in the water of the ashpit causes an increase of steam without a corresponding increase of air, with the consequence that an excess of hydrogen is put in the gas, which may cause difficulties at the engine. This does not take place with the Mathot producer because the air entering the ashpit is saturated with the superheated steam coming down the tubes *C* and any additional steam occasionally produced by clinkers dropping in the water escapes through the openings of the ashpit.

With almost all ordinary types of producer, when the engine slows down or the load drops suddenly, the rate of gasification does not decrease accordingly and an excess of gas may escape in the engine room. This does not take place with the producer under discussion, it is said, because any surplus of gas, being in contact with the air of the open ashpit, burns slowly as it escapes the fire without causing any explosion or smell.

Enriching Producer Gas

By Dow R. Walker

In my experience with gas engines, particularly producer-gas engines, I have often found engines struggling with too heavy loads, engines incapable of handling their rated loads because of poor gas, engines which because of their ignition arrangements would not operate properly on a slow-burning gas, and plants in which the load increased too suddenly for the producers to respond promptly to the demand.

For overcoming these difficulties I hit upon the expedient of introducing gasoline into the gas or air line close enough to the engine to be convenient for the operator and not so close as to give unequal distribution of gasoline to the cylinders. This has been tried on single-acting horizontal, tandem double-acting horizontal and multicylinder vertical engines of different makes, and it has proved highly satisfactory as a means for giving temporary relief.

In one instance, it was adopted permanently to enable a three-cylinder vertical engine to carry about 15 per cent. more load than it was able to carry on the gas supplied. It became imperative that this extra load should be taken care of, and if the engine could not handle it a motor would have to be installed. The engine had 14x14-in. cylinders and was rated at 135 hp. when running 275 r.p.m., but I doubt if it ever developed its rated horsepower.

The gasoline was introduced into the air line of the engine by means of the arrangement illustrated in Figs. 1 and 2. A nozzle was made by flattening and bending a piece of ¼-in. pipe of such a length that the opening came about to the center of the air pipe when the base of the nozzle was screwed into the reducing bushing, as shown in Fig. 1. A needle valve was inserted between the

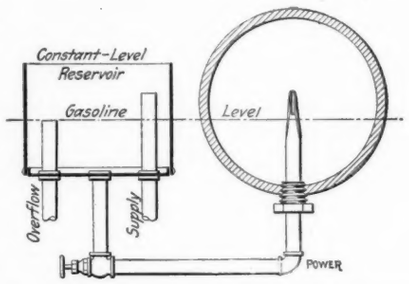


Fig. 1. Connection between Reservoir and Air Line

nozzle and a small constant-level reservoir from which gasoline was fed to the nozzle by gravity. The valve from a water gage does very well for a needle valve and a water bucket can be used as a temporary reservoir. Fig. 2 illustrates the shape of the nozzle. In setting the nozzle in the pipe, the opening should be turned in the direction of the flow of air or gas.

It was decided after the first experiment proved successful to install permanent apparatus to supply the gasoline; accordingly, a 100-gal. tank was buried underground outside the engine room, as shown in Fig. 3, and connected up to the overflow of the little reservoir and to a small pump which was driven by the engine at such a speed that it supplied more gasoline than the engine needed, and therefore kept the level constant at the top of the overflow pipe in the reservoir. The overflow pipe carried the surplus gasoline back to the underground tank and its upper end was so set that the level of the gasoline in the reservoir was just below the outlet of the nozzle. With this arrangement there is no danger of the air pipe becoming flooded with gasoline.

This apparatus was put into operation

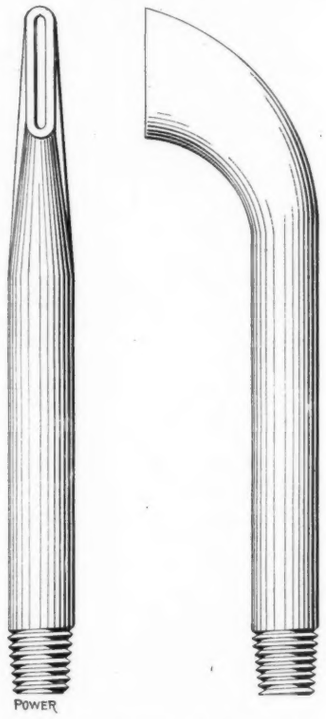


Fig. 2. Shape of Nozzle

over a year ago and so far as I know it is still in use. The engine handled the full load with apparent ease.

In using such an arrangement it is advisable for the operator to set the needle valve open just enough to feed only the gasoline required for the excess load and to see that the producer is kept in full operation, in order that the engine may not use too much gasoline or even run on that alone; gasoline is much more expensive than producer gas.

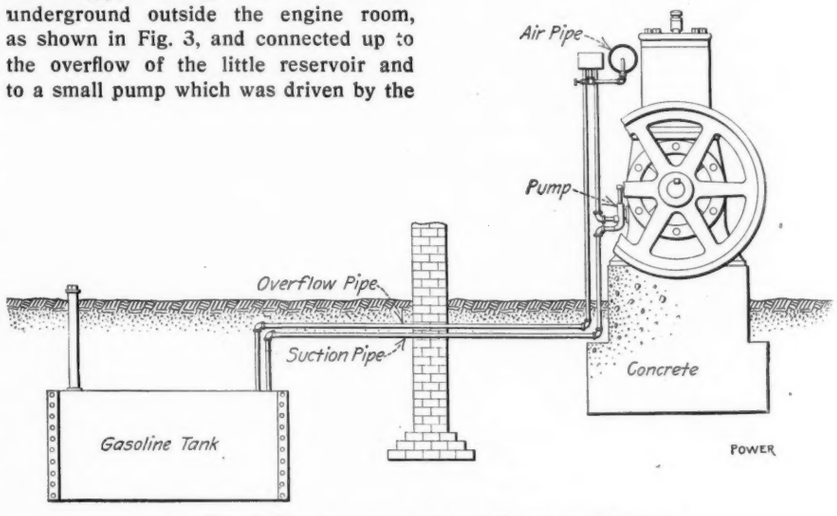


Fig. 3. Piping from Storage Tank to Engine

LETTERS

Improving the Magneto Drive

The magneto on one of my gas engines gave considerable trouble for some time after the engine was installed, and the remedy that I used to overcome the difficulty may be of benefit to someone else having trouble of the same kind. The magneto was driven by friction from the flywheel of the engine through a friction governor wheel on the armature shaft. The governor allowed the friction wheel to bear against the flywheel just hard enough to maintain the proper speed. If set in the intended operating position, the leather disks of the friction wheel would soon wear away until they failed to touch the flywheel of the engine, allowing the magneto to stop; and if pressed firmly against the flywheel, the speed of the magneto would be excessive, causing undue wear of the commutator and brushes.

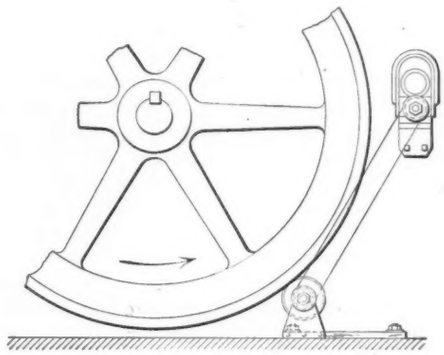


FIG. 1

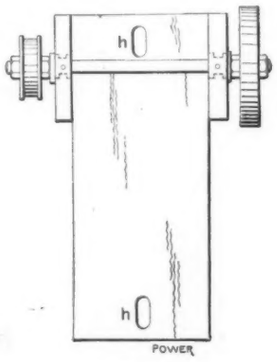


FIG. 2

I decided to try running the magneto with a belt and rigged up a small stand and countershaft on the floor as shown in Fig. 1, setting the magneto on a bracket on the wall with a 3x1-in. pulley substituted for the former friction governor wheel. Fig. 2 shows the plan of the countershaft and its stand on a larger scale.

The base and brackets of the stand were made from ⅞-in. pine lumber. A slot, *h*, was cut near each end of the base to take bolts; the heads of these bolts were fastened in the floor. The holes through the brackets for the shaft were bored to about ⅞ in. and counterbored to about 1 in. for a short distance at each end, filled with babbitt metal and this bored to ½ in., the size of the shaft. This construction, which is indicated by the dotted lines in Fig. 2, holds the babbitt from slipping endwise.

The shaft was made of a piece of ½-in. cold-rolled steel, threaded a short distance at each end. The pulleys were turned up from wooden blocks and fastened on the ends of the shaft by means of faced nuts and washers, one on each side of each pulley, as shown in the sketch.

The larger pulley was faced with leather by gluing a leather strip around it; the shaft and pulleys were then assembled, centered in the lathe and turned true.

This arrangement has been running 24 hours a day for several months and is giving excellent service with a minimum of attention. I have only renewed the brushes twice in this time instead of once every two weeks, as I did before the change was made.

EARL PAGETT.

Coffeyville, Kan.

A Broken Piston

A defect which put the piston of a gasoline-engine cylinder out of commission is shown in the accompanying sketch. The top packing ring of this piston is rather close to the end. Either from this cause or on account of a crack forced into the collar when the machining was done on the groove, a section *S* about 2 in. long broke out. This broken piece danced on top of the piston and was plugged through the top, as represented at *T*. The piston top was very thin, being less than ⅛ in. thick, and furnished the least resistance to the sharp plug of cast iron. The clearance allowed the plug to stand up about ¾ in., as shown.

THE PISTON

Fortunately, the cylinder head was strong enough not to be injured, but a new piston was necessary, of course. The incident proves that mechanical imperfections are yet with us, and — the consumer pays the bills.

B. F. WEBSTER.

Scranton, Penn.

Crankshaft and Belt Breakage

In the Dec. 26 issue, Howard S. Knowlton illustrates a fractured bolt in a connecting-rod big end and suggests two possible causes for the fracture. Whatever may have been the cause of the breakage of this particular bolt, it was *liable* to have been broken by the absence of fillets at the shoulders along its length. That is, of course, if the bolt was actually formed as indicated in the sketch. A gas-engine firm of world-wide repute had several failures of the connecting-rod bolts and crankshafts of its engines. It was finally decided that the cause of the fractures was, in the majority of cases, the sharp shoulders with which these parts were turned. The chief engineer issued orders to scrap all the bolts, and all the shafts for engines of under 16 hp., putting the forge and turnery on night shifts in order to replenish the stock with filleted bolts and shafts. This was about four years ago. Remarkably few failures of connecting-rod bolts or crankshafts have been reported in connection with this firm's engines since that date, and those which have occurred have been directly attributable to other causes, such as heavy premature ignitions and the like. The provision of fillets at sharp shoulders is not a matter requiring a great amount of skill, time or money and it is certainly an additional safeguard against fractures which every manufacturer of internal-combustion engines should adopt.

JOHN S. LEESE.

Manchester, England.

In England steam engines furnish the bulk of our electric power in public electricity stations. A few Diesel oil engines are in use, mainly of very small size, and there are a few medium-sized gas engines. One or two stations have water power, but none of these have so far seriously challenged steam. In Germany things are different. It appears, states a contemporary, that of the public electricity works in Germany, 800,000 kw. is installed in exclusively steam stations, 400,000 kw. in gas stations, 250,000 kw. in water-power stations, and 400,000 kw. in combined water and steam stations. These figures are certainly remarkable when viewed in the light of the position in England.—*The Engineer.*

Electrical Department

Conducted to be of service to the men in charge of electrical equipment in the power house

A High-potential Project for South Africa

According to press reports, a 150,000-volt transmission line 600 miles long is under serious consideration by the British South Africa Co. It is stated that a 50,000-hp. generating station is to be located at Victoria Falls, in Rhodesia, and the power transmitted to the Witwatersrand, 600 miles distant.

A pumping station is to be built on the Crocodile River about 500 miles from the falls and 100 miles from Johannesburg. There will be installed motor-driven pumps which, during periods of light loads, will be operated by the surplus power from the turbine station to store water in a large reservoir to be built on the adjacent hills. During periods of maximum demand auxiliary dynamos will be operated by this supply of stored-up energy to generate power.

Without such a scheme of alternate storage and regeneration much of the kinetic energy of the swiftly moving water at the falls would be wasted when the power demand is light, as it commonly is in hydraulic plants in California. This arrangement also permits the plant to be operated continuously at full load, which results in high efficiency.

To guard against interruptions of the system by shutdowns or other contingencies, it is proposed to build a 20,000-hp. auxiliary steam plant about 100 miles from Johannesburg.

Optimus Plating Dynamos

The accompanying engravings illustrate some constructional features and operating characteristics of the "Optimus" electroplating dynamo built by the Munning-Loeb Co., of Matawan, N. J.

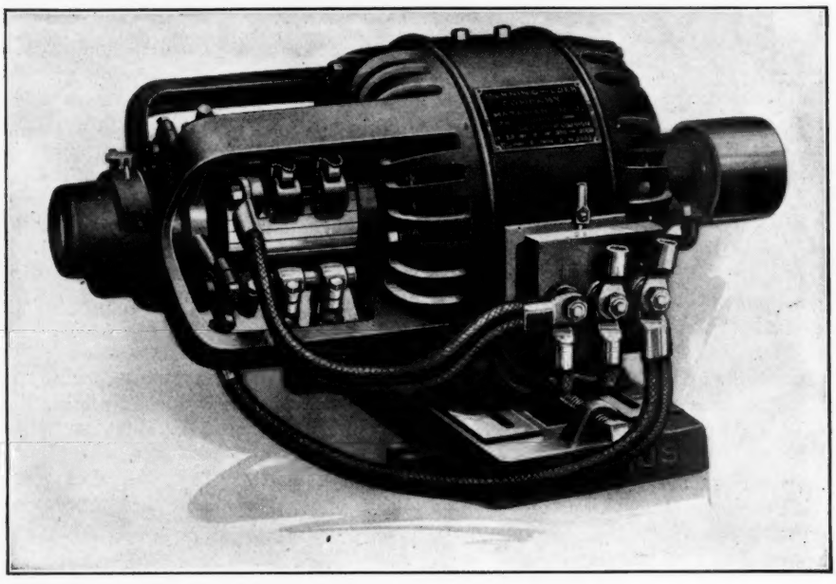


FIG. 1. OPTIMUS ELECTROPLATING DYNAMO

Fig. 1, giving a view of the complete machine, shows that the windings are protected from mechanical injury by a slotted housing at each end of the field-magnet yoke ring, which is unusual in plating machines, although quite common in generators built for lighting and power service. Another feature adapted from high-voltage practice is a composition brush applied to the commutator radially instead of at an angle approaching the tangent of the commutator circle. The brush is described as being compounded from carbon and graphite.

The method of attaching the brush-holder studs to the quadrant arms is a slight departure from common practice. Instead of bushing the hole in the arm with a short insulating tube flanking the arm with washers and following these with a collar and a nut, as indicated in Fig. 2 and generally practised, two insulating sleeves are used and these project considerably beyond the edges of the arm and no collar and nut are used on the brush stud, the latter being held by means of transverse bolts through lugs on the arm, the end of which is split in order to allow the bolts to clamp the "eye" on the insulating sleeves. This construction is illustrated in Fig. 3. It obviously reduces the cost of the studs and their insulation and increases the length of the leakage paths between the studs and the supporting arms.

The Optimus dynamos are compound-wound and very slightly overcompounded,

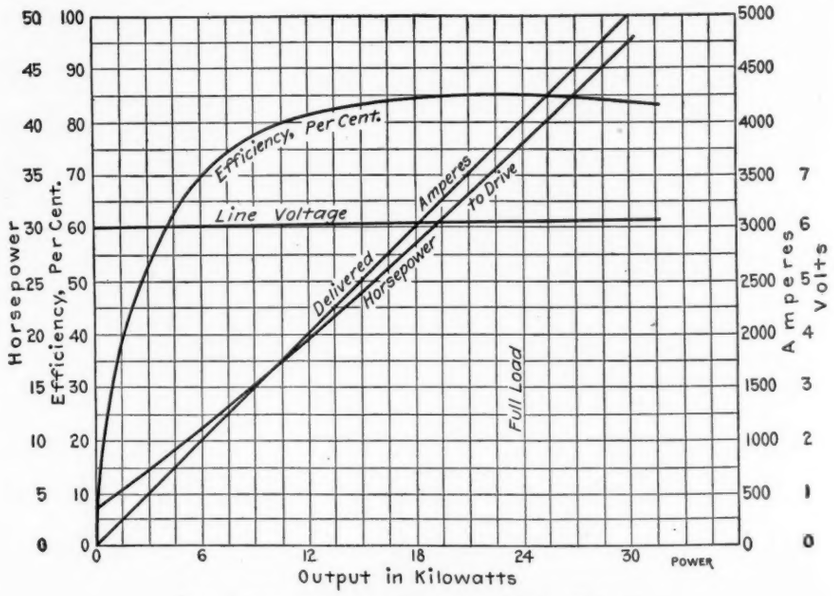


FIG. 4. PERFORMANCE CHART OF 24-KW. PLATER

as inspection of the voltage line in Fig. 4 will show; the electromotive force rises from 6 volts at no load to about

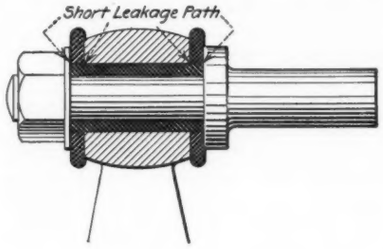


FIG. 2

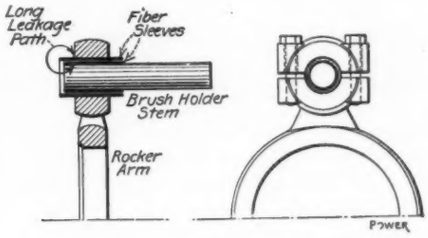


FIG. 3

6.1 volts at full load. This chart, we are informed, was plotted from the results of a test of a 4000-ampere machine.

LETTERS

Mr. Mc Ginnitie's Rattling Exciter

It is to be regretted that Mr. McGinnitie did not give more information concerning the rattling exciter mentioned in his letter in the Jan. 2 issue. Information as to the size, make, speed, voltage, number of poles, etc., would have made it less difficult to advise.

If the armature was not tried for balance on knife-edge bearings, it would be well to go over it again and make dead sure that it is in perfect balance. The smaller the machine and higher the speed, the more important it becomes to have perfect balance. The bearings must fit properly; that is, not only fit the armature shaft, but, if they are of the sleeve type, fit the bearing housings as well. This may be part of the trouble, as at light load the weight of the armature rests entirely on the bearings, while at heavy load there may be an unequal pull on the armature which lifts it momentarily in the bearings and starts the rattling. It would be well to examine the field-magnet coils to see that they are held firmly, and at the same time note if the magnet cores are tight against the yoke.

If the machine is large enough to have several ventilating ducts in the armature core, these should be examined very carefully to see that they are not loose. The plates on the ends of the armature core should be examined also. See that all armature coils are firm in the slots. Test the drop across each field-magnet coil at all loads and see if the drop for each coil is the same. If the machine is a four-pole one and the armature spider has three arms, and the design of the machine is such that the armature core is worked at too high a flux density, the machine may be out of magnetic balance. It is assumed, of course, that the airgap is the same for each pole.

The belt is an important factor in such cases; it should not be allowed to flap, as once oscillation is started it is continually magnified.

I believe that if Mr. McGinnitie will examine the points mentioned he will find a solution to his trouble, although it is just a little puzzling as to what is meant by rattling; there must be some particular spot that rattles, and not the whole machine.

I remember being called upon to locate a rattle in a 500-kilovolt-ampere alternator; after wedging one lamination tooth in the stator core, the machine ran as usual.

L. EARLE BROWNE.

Roundup, Mont.

A Bad Start

I had occasion recently to connect up and start a 20-kw. dynamo which had been set in position before I arrived. After I had made the connections with the switchboard I put the belt on the dynamo and started up; within a few minutes the bearing nearest the pulley began to get hot and the machine to drag. As the bearings were ring-oiled and I had filled the oil wells myself and oiled the shaft before starting and after, I knew that the trouble could not be lack of oil, so I decided to take down the bearing and examine it. The journal box was fitted with a babbitt-lined sleeve held in place by a setscrew. After taking out the setscrew and taking off the journal bracket of the machine, I had to use a jackscrew and chain to get the box off the shaft. When I got it off I found in it a lot of iron borings, many of which, on starting up, had worked onto the babbitt and seized the shaft. After scraping the sleeve and the shaft and cleaning the chips out of the box, the machine gave no trouble.

The dynamo room adjoined a machine shop, and I do not know whether the iron chips were left in carelessly by the man who assembled the machine or whether someone did the trick for spite work. However that may be, I decided that the safest way is to take down and examine the bearings on any new machine, and I shall do that with any that may have to be set up in future, whether it has been examined by anyone else or not.

ALLAN A. BLANCHARD.

Ocala, Fla.

Demagnetizing a Watch

My watch was so badly magnetized that it gained one-half an hour in two hours and would pull a compass needle clear around. I took it to a man who took the magnetism out of it very effectively. He hardly gave me a chance to see his apparatus, but from what little I did see, it seemed to be a simple solenoid or coil supplied with alternating current from the lighting system. He lowered the watch into the center of the coil and moved it slowly up and down.

I do not remember reading anything on how to take magnetism out of watches (you could hardly take it out by heating and hammering them), and as the information would come in useful at some time to some of us, I would suggest that some of the readers who know how to do the trick might give us the benefit of their knowledge through the columns of POWER.

S. G. ROSE.

Brockville, Ont.

[Mr. Rose's surmise that the apparatus used in his case was a solenoid excited with alternating current is undoubtedly correct. Such a coil can readily be made by winding about ¾ lb. of No. 27 double silk-covered wire on a spool 4 in. long with a 2½-in. hole through the center. This may be excited from an ordinary 110-volt lighting circuit carrying alternating current at 60 cycles.—EDITOR.]

Fluctuating Field-Coil Voltage

While measuring the resistance of the shunt field winding of a railway generator by the "drop" method a few days ago, I observed a very peculiar phenomenon. The ammeter in the field circuit read 5 amperes, perfectly steady; the potential at the field terminals was 550 volts and this also was perfectly steady. The voltage across any one field-magnet coil, however, swung violently from about 30 to 70 volts when it should have been about 50 volts steady. I noticed that the fluctuations were exactly in synchronism with the strokes of the engine to which the generator was direct-connected. Subsequent investigation showed that the armature was revolving eccentrically with respect to the pole-face bore. This caused a varying magnetic circuit and a consequent rise and fall of induced voltage in response to the changes of magnetism. The fact that the total voltage across the shunt field winding was constant seems at first to be impossible, but that is as it should be.

F. OPPENHEIMER.

Baltimore, Md.

Heating and Ventilation

Considered as power-plant problems. Layout and operation of systems and apparatus

Steam Heating Large Department Stores*

By Davis S. Boyden

A few years ago one of the largest department stores in Boston had commenced the erection of a new building which would about double its floor area. Up to this time the store had operated its own isolated electric plant, and plans for a new plant were under way. It was then brought to the attention of those in charge that central-station electric service would save the large investment and a considerable amount on the operating costs of an isolated plant.

The operating costs of the proposed plant and the cost of central-station service combined with the operating of a steam-heating plant were threshed out among several of the best engineers, each one furnishing his own estimates. These estimates on the plant costs and on the electric consumption varied somewhat, but when it came to the cost of operating the boilers for steam heating only, there was a wide difference in the estimates and all were much above the figure of the central-station people for operating the heating plant. This wide variation only shows the great lack of information on the subject of steam heating and the fact that its relation to the electric requirement is most generally overestimated. The central-station people received a long-term contract for the electric service, and the actual cost of operating the steam-heating plant during the past two years has fallen well within the estimate made by the engineers of the central-station company.

The department store occupies three large buildings, the old store having a floor area of 273,400 sq.ft., the Francis Building, 69,400 sq.ft. of area, and the Avon Street Building, 295,000 sq.ft., making a total floor area of about 637,800 sq.ft. The Avon Street and Francis Buildings adjoin each other and a tunnel under the street connects these buildings with the old store. The old store consists of a number of adjoining brick and stone buildings of varying architecture from four to seven stories high, with basement. The Avon Street Building is of steel construction, terra-cotta finish, nine stories high, with basement and subbasement. The Francis Building is also of steel construction, brick finish, eight stories high. The accompanying plan shows the arrangement of the buildings and surroundings.

Steam is furnished from the three 250-hp. Babcock & Wilcox boilers located in the sub-basement of the Avon Street Building. These boilers are hand fired and have projecting furnaces of the so called dutch-oven type. The boilers are operated only during the heating season, live steam for the small summer requirement being furnished through a steam main from the boilers in a neighboring building.

The steam-heating system of the old store is of the direct-pressure type, with the exception of the basement, which has an indirect system of heating with forced ventilation. Hand control is used throughout this building, the returns being trapped to the receiver in the boiler room.

The new Avon Street Building and the Francis Building have indirect heating on the first floor as well as the basement, this heating being automatically regulated by Johnson thermostats. The direct radiation on the upper floors is fitted with the D. G. C. automatic return valves, which discharge the condensation direct to the open receiver. The pressure carried on the direct radiation varies from 3 to 6 lb., according to the weather.

The radiation surface and other data regarding heating are given in the accompanying table.

TABLE 1. DATA OF THE THREE HEATING PLANTS

	Outside Volume, Including Basement, Cu.Ft.	Exposed Wall Surface, Sq.Ft.	Exposed Glass Surface, Sq.Ft.	Mechanical Ventilation, Cu.Ft. Fresh Air per Minute	Direct Radiation, Sq.Ft.	Indirect Radiation, Sq.Ft.
Old store	3,706,700	50,353	17,251	40,000	8,122	1,936
Avon Street Building	3,836,000	28,030	26,519	68,000	11,595	4,182
Francis Building	848,300	16,541	7,129	.....	4,368	.....
Totals	8,391,000	94,924	50,899	108,000	24,085	6,118

Test of the Heating Plant

In order to study the daily load curve of the steam-heating plant as compared with the electric-load curve and also to determine the efficiency of the boilers, a two days' test was made on the heating plant.

A number of thermometers were placed throughout the buildings and readings taken hourly at two points on the first and third floors and at one point on the fifth floor of the old store, and at one point on the first, third, fifth and seventh floors of the Avon Street and Francis Buildings. Temperatures were also taken on the roof of the old store and the Francis Buildings while the store was open and access could be had to the roof. The outdoor temperature was taken hourly in Bedford St., near the boiler-room door.

On the boiler test, the amount of steam used for heating is considered to be the total water fed to the boilers and this is true except for steam used by the boiler-feed pump and the small amount used in the kitchen and for hot water. The feed water was measured by a hot-water meter connected in the feed line. Hourly readings were taken on this meter, care being used to keep a constant water level in the boiler. The coal burned during the test was weighed out in 500-lb. lots as fired, but no attempt was made to keep a record of the coal burned each hour, this being affected by any change in thickness of the fire. Other readings taken in connection with the boiler test were feed-water temperatures, boiler pressures and pressures in the lines to the buildings, all taken at 15-min. intervals.

Calibration tests were made on the hot-water meter after using and a plot of corrections made. The meter was found to read about 4 per cent. low for flows of 2.5 cu.ft. per minute and greater. For less than 2.5 cu.ft. per minute, the error increased to as much as 15 per cent. low at 1 cu.ft. per minute, although this should be expected when the meter is designed for measuring a much greater capacity. The corrections from the calibration curve were then applied to the readings of the hot-water meter. The results of the boiler test were as given in Table 2.

TABLE 2. BOILER TEST

Duration of run, hr	48
Total water evaporated, lb	429,800
Total coal burned, lb	47,803
Boiler pressure, lb	77.5
Feed-water temperature, deg. F	211.8
Water per lb. coal, actual, lb	8.98
Water per lb. from and at 212 deg., lb	9.30
Boiler horsepower	268.3

*Paper read before the American Society of Heating and Ventilating Engineers, New York City, Jan. 25.

AVERAGE PRESSURES ON HEATING LINES

1—Intermediate pressure line, lb	33.7
2—New store, direct radiation, lb	4.03
3—Old store, direct and indirect radiation, lb	3.46
4—Francis Building, direct radiation, lb.	1.04

The temperatures at different points in the buildings did not vary widely at any time, and the average for the whole store is used in the plot, Fig. 3. The top curve shows how the average inside temperature varies throughout the day. The temperature falls to 67 deg. during the early morning hours, rising to 70 deg. as the Christmas crowds invade the store. A maximum of 71 deg. is reached when the store closes, the building gradually cooling off again to 67 deg. during the night.

The second curve shows the changes of outside temperature on this day, which is typical of a December day during settled weather.

The bottom curve represents the coal burned that day, apportioned according to the boiler feed-water meter readings. The rise in this curve from 1 a.m. to 4 a.m. is due to the turning on of steam in the Avon Street Building, which had been turned off since 6 o'clock the night before. The more pronounced rise between 5 and 6 a.m. was caused by the turning on of steam and the opening of the air cocks in the radiators in the old store. The third rise at 8:30 a.m. is due to the starting up of the fans of the indirect-heating system. The gradual increase in steam after 3 p.m. follows the setting sun and the drop at 6 o'clock is due to the shutting down of the fans.

To show the close relation between the coal burned each month for heating and the average outside temperature, the plot given in Fig. 2 has been made. As these quantities vary inversely, the solid line representing coal burned has been plotted to read up and the dotted line of average temperatures to read down. The slight variation in the form of these curves during the heating season is due somewhat to outside influences, such as wind and humidity, but principally to the lack of control of the hand-operated radiator valves. Similar curves for buildings having thermostatic control of the heating conform much more closely with one another. If 65-deg. average temperature is used to represent zero coal demand, a much closer coördination of results is obtained.

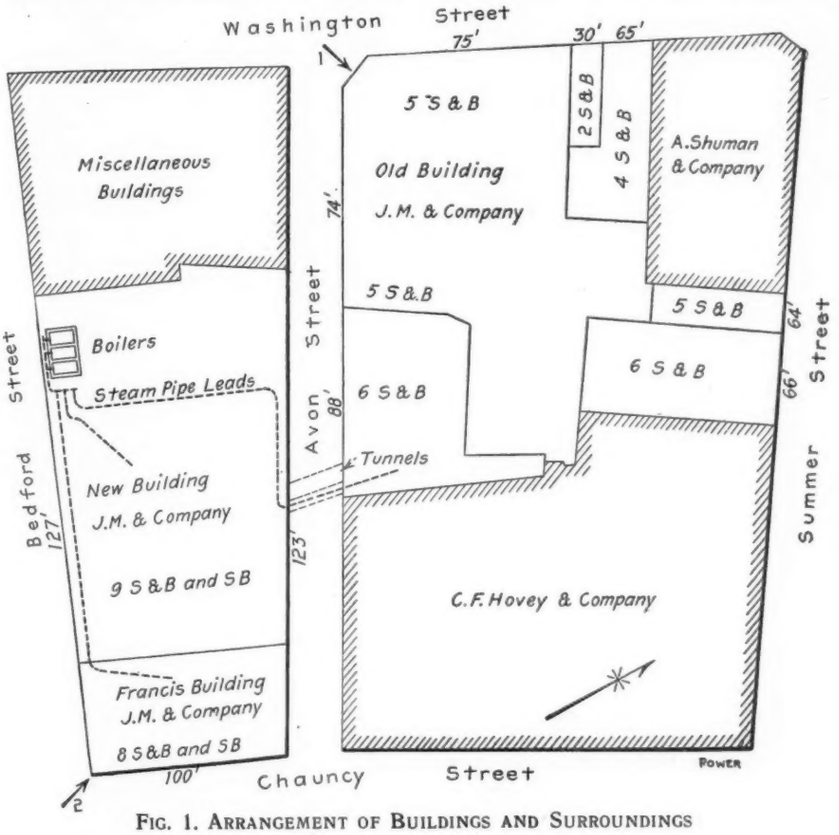


FIG. 1. ARRANGEMENT OF BUILDINGS AND SURROUNDINGS

Electric power and light are furnished from the central station, the standard recording wattmeter accurately measuring the electric consumption. An automatic tape device is also connected with the wattmeters to record the exact consumption throughout the day and these records are on file for reference. The present electrical connected load is as follows:

	Kw.
Incandescent lamps	1998
Arc lamps	653
Iron and electric heaters	6
Elevator motors, 689	514
Other motors, 287	236
Total connected load	3407

The highest demand which has yet been recorded is 1054 kw., which is 31 per cent. of the connected load. This is of considerable interest, because in the case of an isolated plant the generator capacity installed would be from 50 to 70 per cent. of the connected load, not allowing for spare units, when less than one-third of the connected load is the maximum which is used for any half hour. The yearly load factor figured on a 24-hr. basis throughout the year is also of considerable interest to the engineer estimating on the electric consumption of this class of building. The load factor, or the ratio of the average consumption to the maximum, is only 30 per cent. The ratio of the average consumption to the total connected load is therefore

$$31\ (per\ cent.) \times 30\ (per\ cent.) = 9.3\ (per\ cent.)$$

As all the necessary data are now at hand for the consideration of the operation of an isolated electric plant, this phase of the subject will be considered.

The proposed plant, which was not installed, was to have tandem-compound noncondensing engines, which were estimated to generate 1 kw.-hr. on 5 lb. of coal, the exhaust steam being passed through a feed-water heater. The hourly electric consumption for Dec. 20 may then be multiplied by 5 lb. of coal and this plotted as the additional coal required to supply the electric service. The lack of coördination of the two loads is very evident from the plot, Fig. 2, a considerable amount of live steam being used during the night for heating, and by far the greater part of the exhaust from the plant being wasted during the day and evening.

The actual coal burned for heating on this day was 24,000 lb. The electrical consumption for this day would require 60,485 lb. of coal. If the same standard of heating is maintained with the isolated plant as with the heating plant, an additional amount of live steam will be required between the hours of 2 and 8 a.m. This live steam will be equivalent to 4250 lb. of coal, or 17.7 per cent. of the total coal for heating. The total coal used by the isolated plant will be 64,735 lb. The percentage of exhaust from the plant which may be used for heating will then amount to 32.6 per cent. for this particular day.

Assume that this is a fairly average day for the heating season, there being colder and warmer weather when more or less live steam would be required. The total coal used for steam heating during the past 12 months was 1921 tons. Assume that 17.7 per cent. of this would have been live steam from the isolated plant, leaving 1580 tons as the portion of the year's coal which might have been furnished from the plant exhaust. The electric current consumed during the

past year, if the same were generated at an isolated plant, would require 6941 tons of coal, figured at 5 lb. per kilowatt-hour. The portion of this exhaust steam which would be used for heating will be

$$1580 \div 6941 = 23 \text{ per cent.}$$

the remaining 77 per cent. of the steam being used noncondensing with poor economy.

The total cost for operating the heating plant for the year ending Nov. 30, 1911, was $8582.29, during which period 2,776,370 kw.-hr. of electricity were used on the premises. Dividing the cost of heating by the kilowatt-hour use, it is found that the cost of heating is equivalent to 3.0909 mills per kilowatt-hour used. Should a reduction be made of the cost of coal required to furnish the live steam for heating, which is 0.5471 mill per kilowatt-hour use of electricity, the total value of the exhaust steam per kilowatt-hour would be 2.5438 mills.

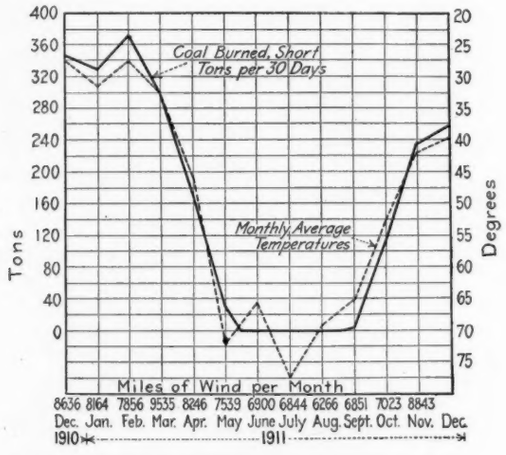

Coal Burned, Short Tons per 30 Days
Monthly Average Temperatures
Tons
Degrees
Miles of Wind per Month
8636 8164 7856 9535 8246 7539 6900 6844 6266 6851 7023 8843
Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.
1910
1911

FIG. 2. RELATION BETWEEN COAL BURNED FOR HEATING AND AVERAGE MONTHLY TEMPERATURES

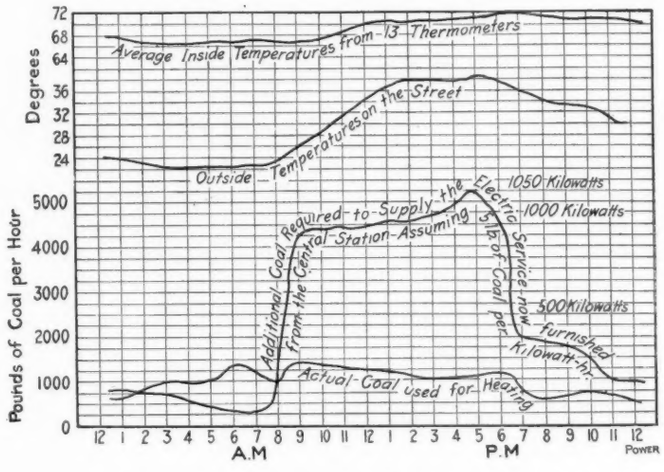

Average Inside Temperatures From 13 Thermometers
Outside Temperatures on the Street
Degrees
Additional Coal Required to Supply the Electric Service now furnished from the Central Station Assuming 3 lb. of Coal per Kilowatt-hr.
1050 Kilowatts
1000 Kilowatts
500 Kilowatts
Actual Coal used for Heating
Pounds of Coal per Hour
A.M
P.M
POWER

FIG. 3. RESULTS OF TESTS MADE DEC. 20, 1911

TABLE 3. ITEMIZED COST OF HEATING WITH EQUIVALENT COST PER KILOWATT-HOUR USE OF ELECTRICITY

Item	Cost for Year Ending Nov. 30, 1911	Mills per Kw.-hr. Use
Miscellaneous expense	$122.84	0.0442
Fuel	5718.14	2.0596
Water	229.94	0.0828
Oil and waste	7.35	0.0026
Labor	2331.44	0.8391
Repairs to mechanical appliances	38.20	0.0138
Repairs to boilers	134.38	0.0488
	$8582.29	3.0909

It may be a ready means of comparison to append the deductions in Table 4.

TABLE 4. THE RELATIVE COST OF STEAM AND ELECTRIC SERVICE PER CU.FT. OF SPACE AND PER SQ.FT. OF FLOOR AREA

	Cost per Cu.Ft. of Volume	Cost per Sq.Ft. of Floor Area
Steam	$0.00102	$0.01345
Electric	0.00641	0.08436
Total	$0.00743	$0.09781

Electric Heating in Norway

Initial steps are being taken in Stovanger, Norway, writes U. S. Consul P. Emerson Taylor from that city, for the installation of a system of electric heating. A few firms are already heating their establishments by electricity, and have purchased and installed German apparatus and fixtures for that purpose.

The board of directors of the city electric-light plant has asked that the city council give it full power to make all contracts with firms desiring to install electric heating and has transmitted to it the application of one of the larger firms for the use of 100 hp. from the city plant for heating purposes.

The contracts proposed by the directors of the light and power plant, if approved by the council, provide for the sale of power for heating to firms and individuals for a period of five years, with the option on the part of the purchasing firm or individual to extend the contract for another five years, the city to have the right to change or cancel the contract any time after the first five years, should it be necessary, upon giving one year's notice. The contracts further provide that between 4 and 7 p.m. during the winter season when the maximum light power is required the city may, if necessary, restrict the firms to an amount below the maximum named in their contracts.

Many of the factories will use electric current both day and night for heating, and the cost will therefore be very reasonable. As so much of the city's available power goes to waste or is unused except between the hours of 4 and 7 p.m., both the city and the prospective purchasers of current for heating look forward to the installation as an economical proposition.

While the price for electric power for heating has not been definitely determined by the council, the price proposed by the directors is 25 crowns ($6.70) per horsepower per year, and this will in all probability be the rate.

The present capacity of the city electric plant is 8000 hp. Of this amount 4800 hp. is now in use, about one-third being employed for light and two-thirds for factory power. The city, which has a population of 38,000, is constantly installing additional lights and selling additional power to the factories. Although the capacity of the present electric plant is only 8000 hp., the city owns, in addition to the waterfalls used for the power of the present plant, two other waterfalls, and by connecting with these and enlarging the plant it will be able to furnish 25,000 hp.

By the plans and contracts proposed the city will merely sell the power to the firms and individuals desiring to use it, the purchasers themselves installing the heating apparatus.

Charge for Steam Heat

I am in charge of a 300-hp. plant in a hotel and will soon be obliged to furnish some steam for heating. I would like to hear from readers of POWER as to what unit I should adopt for measuring it and what rate should be charged.

C. E. DIAMOND.

Stockton, Calif.

Nearly 500 lantern slides on steam turbines, governors, valve-setting and various power-plant and technical subjects will be lent by the Institute of Operating Engineers to organizers and others in connection with its educational work. The use of these slides has been made possible through the courtesy of Frank Martin, Willis Lawrence, Asa P. Hyde and Hubert E. Collins. A list of slides may be obtained on application to the secretary of the institute.

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POWER

New York City's Coal Problem

Elsewhere in this issue is an outline of the procedure adopted by the Department of Water Supply, Gas and Electricity of New York City regarding the purchase of coal for the numerous pumping stations coming under its supervision. When these specifications were first put into effect, about two years ago, they met with strong opposition from certain quarters. It was claimed that they would impose an unnecessary hardship upon the coal dealers; that the latter would raise the price to protect themselves against penalties; that competition in bidding would be lessened; and that the city would be the ultimate loser.

Whether any of these or other similar predictions have come true matters little, although it might be mentioned that the penalties have been surprisingly small. The all important fact remains that the city is now receiving a better quality of coal than formerly and that during the first year of buying coal under the new specifications a saving of over one hundred and twenty-two thousand dollars was effected in the coal bill of this one department. In the various bureaus under the jurisdiction of the president of Manhattan Borough, which employ specifications similar to those of the Department of Water Supply, Gas and Electricity, a proportionate saving was effected.

In fairness to those largely responsible for the saving, it may be said that the whole credit for it should not be given to the specifications. A large part of it was brought about by giving special attention to individual cases, changing furnaces and grates to burn certain coals economically, and, in short, applying scientific principles to combustion.

Unfortunately, the administration of a large city is cumbersome and necessarily involves much of the so called "red tape" which is plainly evident in the procedure as outlined. In this connection it would be interesting to know how much it actually cost the city for the services of experts and inspectors to enforce the specifications. Of course, in order to arrive at the actual saving in dollars and cents it would be necessary to deduct this additional expense from the apparent saving. Perhaps those in a position to compile this information will enlighten us.

However, we believe the city has made a good start in the handling of its coal problem and will doubtless make certain modifications tending toward simplicity as the conditions warrant.

The British Thermal Unit

Reginald Pelham Bolton, at the recent meeting of the American Society of Heating and Ventilating Engineers, of which he is the retiring president, submitted a plea for the abandonment of the use of the term "British thermal unit" in favor of the more simple expression "heat unit" for the unit quantity of heat.

It would seem to make little difference whether this quantity were called a "heat unit" or a "thermal unit," except that the former is less pedantic and the latter accords with the German *Warme-einheit*. A single word, as the French have in *calorie*, would be better than either. The adjective British was presumably attached to distinguish the English from the Continental or metric unit. British is wider than English politically and geographically, but narrower where language and customs are concerned. For Great Britain itself, the abbreviation B.t.u. has the disadvantage that it is identical with the much used abbreviation of the Board of Trade unit of electric energy, the kilowatt-hour.

Of greater importance, however, than the changing of the name is the definite determination of the significance of the name; the positive definition of the quantity to which the name applies. The tyro learns that the unit by which quantities of heat are measured in the English system—call it the B.t.u. or what you will—is that amount of heat necessary to raise one pound of water one degree Fahrenheit, and he is satisfied and happy—until

he learns that the specific heat of water varies with the temperature, that it takes more heat to raise the temperature of a pound of water one degree starting from one temperature than it does starting from another. And then he learns that some authorities consider the heat unit as that amount of heat required to raise the temperature of a pound of water one degree from the freezing point, others from its point of maximum density about 39 deg.; others from 62 to 63 deg., because this is about the temperature of the room in which experiments are supposed to be made, and others still, the average heat per degree rise in temperature between 32 and 212.

The difference is not great enough to be of importance in ordinary work, but there should be a clear conception of the basis of so important a physical unit and its name, when adopted, should mean something definite. Uniformity of usage and precision of statement are the ends which should be sought.

The Manhole Frame

In the tests to destruction of two return-tubular boilers, twenty-seven years old, recently conducted by James E. Howard and reported in the Dec. 5 issue of POWER, the cast-iron manhole frame failed under a hydrostatic pressure of 270 pounds. Similar tests at Ishpeming, Mich., on three boilers thirty years old are described on other pages of this issue, and in each case failure occurred at the manhole.

On two of the boilers the frame broke at pressures of 260 and 275 pounds respectively. On the other boiler the manhole frame had been replaced with a patch and at 300 pounds pressure thirteen of the patch bolts sheared. Subsequent tests of the metal showed that the boilers were as good as the day they were made, and omitting the fact that the rivet holes had not been reamed, the workmanship appeared to have been excellent. In no way had the boilers deteriorated in the long service to which they had been subjected.

Eighty pounds had been allowed as the working pressure of these boilers, and with failure at 260 pounds it is evident that the factor of safety of the manhole frame was only 3.25, and, therefore, considerably below that usually specified. Evidently the design of this frame is at fault, and more particularly the material of which it is constructed.

The stress developed at the side of the manhole, due largely to the rigidity of the frame, was, of course, excessive, but at best cast iron is poor material to use in boiler construction and for high-pressure work should not be tolerated.

What a Piece of Waste Can Do

Nothing is more innocent-looking than a piece of clean, white waste; nine-tenths of the operating engineers have some of it in their jumper pockets and the other tenth will have a bit in their hands. But, notwithstanding its harmless appearance, it is dangerous unless kept in its proper place, used for legitimate purposes and properly cared for when it becomes oil-soaked and dirty.

Mysterious fires have had their origin in a piece of dirty, oily waste thrown into a corner by some careless person, and then when spontaneous combustion takes place people wonder what caused the fire.

It is not unusual to find that an oily waste can, such as is provided in factories, contains nothing but the ashes of charred waste; particularly is this noticeable after a shop has been shut down for a few weeks. Someone neglected to empty the waste can and the property was consequently jeopardized.

Waste left in a boiler has been the direct cause of bagged plates. The heavy particles of foreign matter precipitated from the water when the boiler was under steam pressure gathered on the piece of waste and, settling on the fire sheet, caused it to overheat and develop a bag which necessitated more or less extensive repairs.

Not long ago we published an account of an engine wreck in which the engineer lost his life. The cause was a harmless-looking piece of waste which was found tightly wedged between the gears of the governor. This permitted the engine to run at such a speed as to disrupt the flywheel, which caused the engineer's death.

The neglect of apparently trivial conditions often results in serious accidents. Safety in small matters is frequently as important as are those of greater moment. Often the results due to the condition of small details will result as disastrously as those occasioned by neglect of the greater ones.

There were twenty-seven boiler explosions in the United States and Canada during November, and they caused nine deaths. In October there were thirty-five explosions and fifteen persons killed. A steam boiler is more dangerous than dynamite in the hands of incompetent persons. Perhaps an investigation of the causes of these accidents would show a high percentage of incompetency and careless operation.

The wage question in this country has a modicum of consolation when we consider the recent letters on power-plant wages in China, and that an English farmhand gets $126.53 a year, "with house and potatoes, when his wife assists him."

A New York surgeon was sued by a man who claimed that the doctor neglected to remove an instrument after an abdominal operation. This reminds us of the careless fireman who left a hammer in a boiler after cleaning it. Either "boiler" might have been damaged beyond repair.

"Let us be a mother to you," is the entreaty of an advertiser in the *Rose Technic*. We are too old for anything like that, but if anyone will father a good operating kink or act as "assister" in making POWER an even better paper than it now is, we will gladly meet him more than half way.

James Watt was worried by a man who claimed to be able to evaporate a hogshead of water with an ounce of coal. Had the chemical compound faker gotten to work so soon?

Two boiler explosions in New York City and nobody killed, but look out; there is an old saying that the third time never fails.

The endeavors of Dr. Duncan, of the University of Kansas, and other scientists to make petroleum edible should help to pour oil on the troubled waters of the high cost of living.

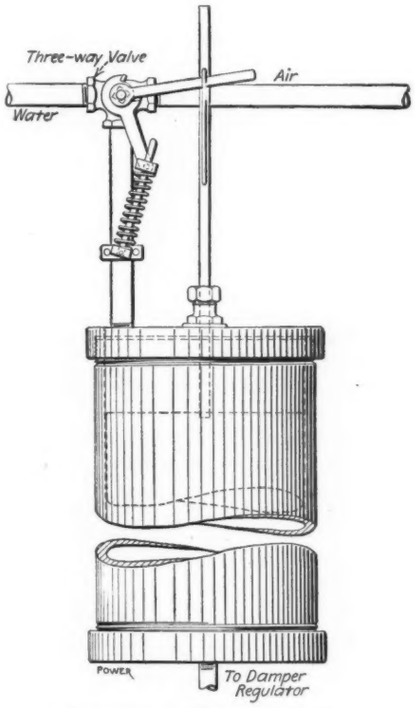
Readers with Something to Say

A letter good enough to print will be paid for. Ideas, not mere words, wanted

Air Operated Damper Regulator

The accompanying sketch illustrates an apparatus for operating a damper regulator in plants where the water pressure is not sufficient to operate a damper regulator, but which have a compressed air supply.

The tank is made out of a steam pipe with a cast-iron cap screwed on each end. I use a three-way valve, one side running to the water pipe, the other end to the air supply and the third to the tank;



DETAILS OF WATER CONTROL

a lever is attached to the three-way valve operated beyond the center by a loose lever which is moved by a float-rod and thrown quickly by means of the coil spring after passing the center. It operates alike in both directions. When the valve is thrown to the water inlet a port is open to the air, thus relieving the air pressure on the tank and letting the water in. When the tank is full, the valve is thrown, shutting off water and admitting air pressure on the water.

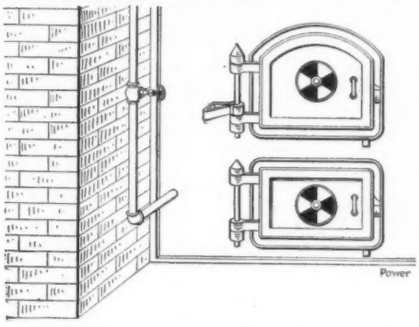
I use 80 lb. air pressure. A pipe leads from the bottom of the tank to the damper regulator.

W. I. CRAWFORD.

St. Louis, Mo.

Triangle Door Buffer

The accompanying illustration shows a triangle hung on the rod that carries the furnace door on a boiler front and is for the purpose of keeping the door from swinging too far back. In our case



DOOR BUFFER FOR FURNACE DOOR

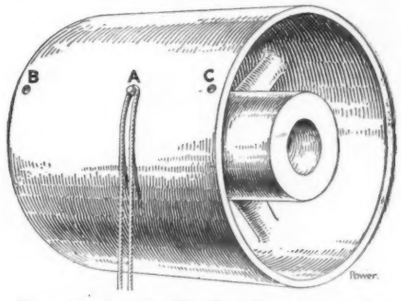
the drain pipe from the water column was run down a wall, but in the way of the door. The triangle was used to protect the pipe.

THOMAS O'CONOR.

Golden, Colo.

Cord Pulley Lagging

To cover a pulley cheaply and quickly, drill a small hole about $\frac{1}{16}$ in. in diameter in the face as at *A* and drive in a small pin and cut off about $\frac{1}{8}$ in. above the pulley face; then obtain a continuous hard, twisted cotton cord $\frac{1}{8}$ in. in diameter and free from knots, and loop the middle point of the cord over the pin. With the free ends held tight,



PULLEY ABOUT TO BE LAGGED WITH CORD

turn the pulley in the direction of rotation, applying a good coat of belt glue as the cord is wound on the pulley. When the face of the pulley is completely covered, draw the free ends through the holes marked *B* and *C* on the sides and fasten with a soft wooden pin well covered with glue. As soon as the glue hardens, the pulley will be ready for use.

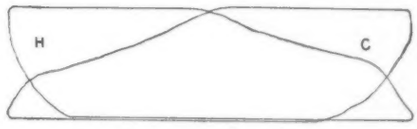
The pulley surface should be thoroughly cleaned before applying the glue. As the cord forms a right- and left-hand thread, so to speak, the belt will tend to work from the side to the center, which will insure the belt running on the center of the pulley. The length of cord for one turn may be found approximately by multiplying the diameter of the pulley by $3\frac{1}{7}$, and this multiplied by the number of turns necessary to cover the face will give the total length. This pulley cover is easily cleaned and will last a long time.

D. H. HULL.

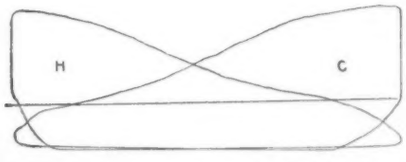
Asylum, Miss.

Diagrams from Three Cylinder Compound Engine

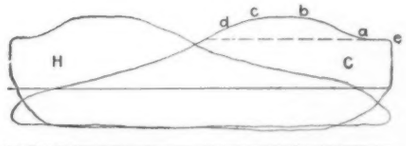
The accompanying diagrams were taken during the past season from the engines of the Morton line steamship "City of Benton Harbor," plying between Chicago and St. Joe, Mich. They should be of special interest to those engineers who are not familiar with the three-cylinder compound type of engine.



High-Pressure Diagrams



Port Low-Pressure Diagrams



Starboard Low-Pressure Diagrams

The starboard low-pressure diagram is of more than passing interest as it introduces a phase of indicating not often met with in everyday practice and of educational value to beginners in the study of engineering science.

The feature of interest in this diagram is the peculiar steam line as indicated by the hump *abcd*. When I removed the card from the paper barrel of the indicator it caused me considerable surprise, for I had expected to see diagrams similar to the port low-pressure diagrams. The chief engineer, who was familiar with this eccentricity of his engine, assured me that the diagram was as it should be and the test was completed.

The "City of Benton Harbor" was built for the Graham & Morton line at the Craig shipyards at Toledo, Ohio. The installation of this type of engine was due to the desire of the ship's architect to avoid the cumbersome beam type of engine for side-wheel propulsion. The engines are at an angle of approximately 22 deg. to the keel. The cylinders are high-pressure, 38 in. in diameter, both low-pressure, 55 in., and the stroke is 78 in. The maximum speed of the engine is 42 r.p.m. and the boiler pressure is 145 lb., gage.

The high-pressure diagram is an excellent example of engine performance for this type of prime mover. Each low-pressure cylinder is served by an independent jet condenser. This explains the differences in vacuum shown by the exhaust lines of the diagrams.

The marked differences in the steam lines of the two low-pressure diagrams are explained by the fact that at a certain crank position both low-pressure cylinders take steam for a period dependent upon the cutoff and position of the valve-gear of the port low-pressure cylinder. Referring to the diagram, it will be seen that both low-pressure cylinders are taking steam from the admission line *e* to the point *a* at which the cutoff takes place in the port cylinder. Then, the receiver pressure increases as the starboard piston advances in its travel until the maximum pressure is reached at *b*. This pressure is constant until the piston has reached *c*, when a noticeable drop in pressure begins. The cutoff is approximately at *d*.

JAMES B. ROGERS.

Chicago, Ill.

Repaired Pump Piston Rod

When I took charge of my present plant the water end of the brass piston rod of the boiler-feed pump was so badly worn and scored that I could not keep it tight nor enough water in the boiler when the engine was working hard.

I filed the rod smaller at the worn part and fitted a tin ferrule over the rod and ran the cavity full of hard solder. By keeping the rod packed with soft packing, liberally supplied with graphite, it gave good service for some months.

A. W. CARD.

Glenboro, Can.

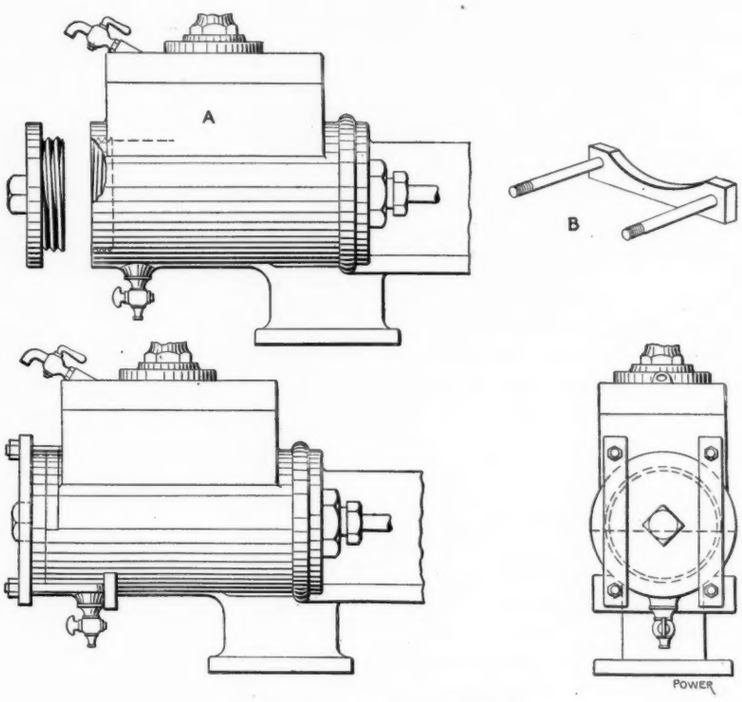
Repaired Broken Pump Cylinder

A small boiler-feed pump that was left without draining became frozen one cold night and the water cylinder head was forced out of the cylinder. The head on this pump was screwed into the cylinder like a plug; therefore when the head came off, it took some of the cylinder with it, as shown at *A*.

I cut off the broken portions and chipped out the threads remaining in the cylinder so that the head would fit in without screwing. Two holes were next tapped in the valve-chest, into which two studs were screwed. A yoke *B* was made to fit behind the projection where the drain cock screwed in. The head was replaced in the cylinder, the openings were filled with Smooth-On, and I put two straps across from the studs to the yoke; then I put on the burrs, and tightened the nuts.

J. L. DONOVAN.

Vancouver, Wash.

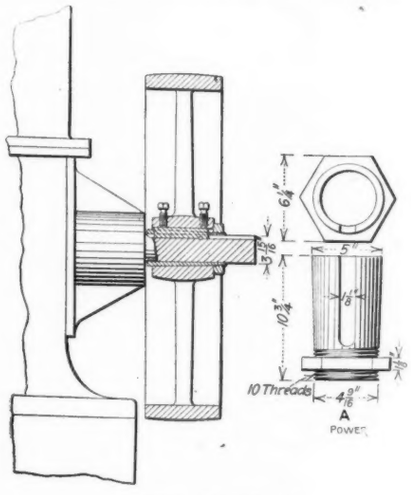


DETAILS OF THE REPAIR JOB

The Flywheel Bushed

The company I work for has a 12x11-in., single-acting, double-cylinder, upright engine, driving two 20-kw. generators; the engines run 285 r.p.m. Considerable trouble has been experienced lately because the setscrews of the two flywheels work loose. On one occasion it was only by sheer luck that the engineer in charge noticed that one of the wheels had worked loose and was about ready to plunge off of the shaft when he stopped the engine.

A taper bushing was made with the dimensions shown in the illustration *A*, and a slot ⅛ in. larger than the key of the wheel. The smaller end of the bushing was threaded with 10 threads to the inch for a nut—a coarser thread could not be used on account of the thin walls of the bushing; also, the fine thread will not allow the nut to work loose as easily as a coarse thread. The flywheels were then removed, the bushing slipped onto the shaft (the bushing being bored out to a size so as to slip onto the shaft without driving), and the flywheels put in place on the bushing; then the nut was screwed in and drawn up as tight



BUSHED FLYWHEEL

as possible. The wheels having been bored to the same taper of the bushings on account of the fine thread, the wedging action was very powerful.

After the engine had run for two or three days the nut was tightened again, and for the past six months nothing has been done to the bushings and there are no signs of the wheel being loose on the shaft.

V. T. KROPIDLOWSKI.

Winona, Minn.

Indicator Cords Responsible for Diagrams

The mechanical engineers had attached the indicator and taken some friction diagrams leaving their indicators to get some load diagrams later. During their absence I got busy, and after taking a few, I obtained the diagram shown in Fig. 1. It puzzled me for a time until I noticed the diagram was close to the end of the card, and on examining the indicator, I found that the cord was too long, and the drum striking the stop had caused the short compression line. I put a couple of knots in the cord and obtained the compression diagram shown in Fig. 2, which brought the compression very nearly the same at both ends of the cylinder. This diagram was obtained by lifting the latch on the steam gear and so preventing the steam from entering the cylinder, and then the diagram shown in Fig. 3 was taken.

The rounding corner of the diagram at the point of cutoff is partially accounted for by a worn corner on the tripping lever.

The engine has an 18x42-in. cylinder fitted with double-ported Corliss valves.

As the mechanical engineers did not return, I inquired if they had noticed any difference in the diagrams, and I produced those I had taken. An examination showed many good diagrams among the first ones taken, but the last ones were the same as mine. This made a difference of 2 hp. in the friction load on the head end of the cylinder.

Even with this change a strange feature was noticed by comparing the head-end diagram with one taken from the crank end. Although the change in the length of the cord brought the diagram back nearer the center of the card, the head-end diagram is about ¼ in. shorter than the one taken from the crank end of the cylinder. Separate indicators were used with pantograph reducing motion, and the cords from both indicators were attached to the same pin on the pantograph. The cord from the indicator on the head end passed back of the indicator over a pulley and was attached to a spring which was hitched to the floor; that is, the indicator cord was hooked in a loop of the cord connecting the pantograph to the spring. It may be possible that the cord stretched enough to make ¼ in. difference in the diagrams, but it was one that had been used many times and showed no signs of stretching when tried with the hands. The spring attached to the floor was a very weak one and it seems incredible that it should cause the cord to stretch. I should like to hear from POWER readers regarding these diagrams.

R. A. CULTRA.

Cambridge, Mass.

A Hot Box Cure

At the mill where I am employed as engineer, I have had trouble with the bearings next to a 44-inch drive pulley on the line shaft, which is belted direct to the engine. The whole load of the mill on these bearings caused them to run hot.

I tried different remedies, but nothing seemed to help them until I removed the oil cups and poured in some kerosene, letting it run through the bearings while they were in operation. I allowed the shaft to run thus for a few seconds and then poured in some castor machine oil, and after that some more kerosene oil, and finally, in a few seconds, I applied more castor oil.

After thus applying kerosene and castor oil several times, I poured water through the bearings and washed them out and then applied cylinder oil. After this I replaced the oil cups. The bearings soon began to run cool and have not given any further trouble.

This treatment seemed to take the dirt and grit out of the bearings and polished the shaft.

I also remedied the main bearing on the 14x18-inch engine, which has a 6-inch shaft. Kerosene cuts the film of oil between the shaft and babbitt and brings them into contact close enough to loosen the dirt and grit, and smooth off the rough places. The shaft seems to polish up better for this treatment.

Care should be taken not to allow the bearing to run more than a few seconds in kerosene without applying castor oil.

G. D. WIANT.

Seattle, Wash.

Need of Trades Schools

At the present time the number of trades schools in the United States is very small. If a comparison is made between the number of people employed at trades and the number of professional and cultured men and then between the number of professional and cultural schools and high schools, and the few trades schools, a good example is had of an inverse ratio.

Germany and a few other European countries have well established and successful trades or continuation schools.

Why, then, should the United States, having, as we believe, no equal in the other countries of the globe, be so tardy?

I am glad that there is room for belief that the people of the United States are waking up fast to this great need.

From the information I have been able to secure I believe that Massachusetts and New York were the first states to legislate for the promotion of industrial education and both of these states have several vocational schools in an embryo state.

Following the example of Massachusetts and New York, during the year 1911, 11 states legislated for industrial and trades training; besides, Mr. Page introduced a bill in the United States senate providing for national aid in cooperation with the states for industrial training.

At present, excepting the United States Indian schools and a few high schools in Massachusetts and New York, the schools teaching operating engineering are run by private individuals.

In every engineering course, mathematics and the machinist trades are requisites.

It is all well enough to say that if a boy wants to be an engineer, he should study; so he should, but until the states start such schools, if he learns the machinist trade he has gained only one big

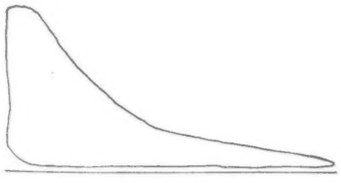


FIG. 1

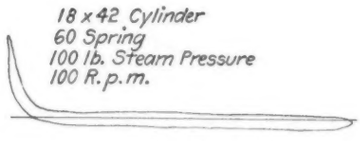


FIG. 2

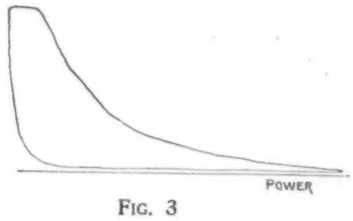


FIG. 3

THREE DIAGRAMS FROM THE SAME ENGINE

step upward, toward being a high-class engineer.

In the government Indian schools the practical side of engineering is being taught with enough of the theory to enable graduates to secure licenses.

At the Cushman Trades School in Tacoma, high-school pupils of the city schools will be allowed to learn the woodworking or machinist trade or operating engineering. The school was opened to the public on Jan. 1, 1912, and may be said to be the first trades school in the United States to have been equipped by the government.

If engineers want to further their interests they must organize and educate themselves, and, if necessary, get on the school boards and help start technical high and trades schools. If a demand is created for operating-engineering schools it will be supplied, but the quicker the engineers act the quicker they will come.

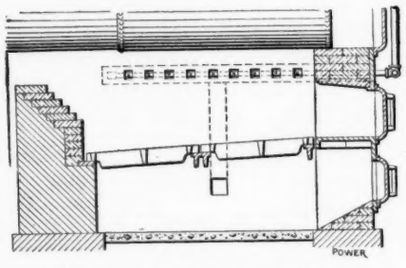
ROY V. HOWARD.

Tacoma, Wash.

Home Made Smoke Consumer

The engineers of a steam plant were arrested periodically for violating the smoke ordinance. This resulted in the frequent changing of engineers, and finally a smoke consumer of good repute was purchased and installed, but it failed to come up to expectations. A new engineer came and he put up a smoke consumer of his own make which brought about the desired results.

A 1-in. steam pipe was brought down



DETAILS OF SMOKELESS FURNACE

in front of the boiler and branched off into two ¾-in. pipes below the smokebox doors, one for each side of the furnace. These pipes extended into a channel 4 in. square which was built inside the firebrick wall well above the grate line. Eight 2-in. square holes evenly spaced opened from this channel into the furnace.

The channel was also connected with the ashpit by means of a vertical channel 4 in. square. The ¾-in. pipe was tapped for eight ⅜-in. steam nozzles, the nozzles being made to correspond with the opening in the horizontal channel. As the steam was turned into the steam nozzles, it would induce draft, drawing air from the ashpit into the furnace. As the steam is regulated by hand, any amount of draft might be induced, as required.

VICTOR BONN.

New York City.

Wanted: Engineer Who Can Iron Shirtwaists

According to the papers, this is a day of specialists, but the rule does not seem to hold good in the case of engineers.

I have been in places where they expected one to be a first-class engineer and be well up on plumbing, blacksmithing, masonry and tinsmithing, but I met with something new not long ago.

While in a large Western city I noticed an ad calling for an engineer-laundryman. I called and found it to be an institution run by a state organization. I informed them that I could run the engine, boilers, steam-heating plant and the laundry machinery as well as look after the plumbing, having had experience in all those lines.

Then the superintendent stumped me by asking if I could iron shirtwaists. I confessed my ignorance and did not get the job. Next!

FRED ECKLEY.

Bakersfield, Cal.

Dirty Boilers Cause Trouble

A few years ago I ran, as night engineer, a lighting and heating plant. The outfit consisted of one 175-hp. water-tube boiler and two 80-hp. fire-tube boilers. One 50-kw. and one 100-kw. engine. The boilers were fed from a receiver which received the returns from the heating system, but there was no oil separator or filter in any of the return lines.

Everything went nicely so long as the load was light, but as soon as a heavy load came on, then the trouble began. The large engine would begin to cluck like a setting hen, and then I had to close the throttle and open up the bypasses to the traps connected to the steam separators. While this was going on the lights were burning dimly and then the consumers would protest.

The only cause for this trouble was that the boilers were not properly cleaned. They would run four weeks with no trouble without washing out; after that I had to look out. The chief was satisfied with conditions and that settled the matter.

Another heating and lighting plant contained four 400-hp. water-tube boilers. The chief engineer congratulated himself because his boilers were so free from scale, but the fireman complained that the boilers were steaming hard. A tube-cleaner was purchased and tried out, and the back end of every row of tubes was found to be badly scaled. Cleaning the tubes every three months kept the boilers in good condition.

The Corliss engines were of the cutoff type for overloads up to 75 per cent. When an overload came on the engine, the receiver pop valve would blow and the vacuum would be lost. Then the load had to be thrown off before the vacuum could be reëstablished. This would happen six or eight times daily. The cause for this was found to be due to the reach rod on the high-pressure side controlling the knockoff cams being too long and more steam went to the receivers than the low-pressure cylinder could take care of. As soon as this rod was shortened the troubles ceased.

The low-pressure cylinder had two set of packing rings in the piston; the high-pressure cylinder had one piston-packing ring. It was noticed that the packing ring did not reach the counterbore at each end of the stroke of the piston by ⅜ in. The low-pressure cylinder was nice and smooth to the counterbore, but in the high-pressure cylinder a shoulder was formed and as soon as the old packing rings were worn out the trouble commenced. New rings were put in but were soon broken.

Engineers should be sure when an engine is set up or when the cylinder has been rebored that the piston ring overlaps the counterbore a trifle. When a cylinder gets a shoulder $\frac{1}{16}$ in. deep, there is only one sure remedy, and that is, rebore the cylinder and fit a new piston.

The water for boiler use in another power plant was taken direct from a small river and every time it rained the water became very muddy. After a boiler was cut in on the line the blowoff valve was never opened until the boiler was washed out, a period of from four to eight weeks. Sometimes there would be so much mud that a jack would have to be placed against the manhole plate before the mud and water could be got out of the boiler. When a heavy load came on the engines, and the fireman began to crowd the fires, mud and water were carried over into the engines, the vacuum was lost and the engines then exhausted to the atmosphere. Then down went the voltage. Things were no more than straightened out again when the same things would repeat themselves.

One day a heavy load came on a small tandem-compound engine and then suddenly went off; the governor opened up and stuck; the engine began to race, and before the throttle could be closed the engine had attained a dangerous speed. Shortly after this experience the same engine again ran away and was not brought under control until it had shattered the flywheel, one half striking the switchboard; the other half struck against the wall and fell into the pump pit.

E. E. MILLS.

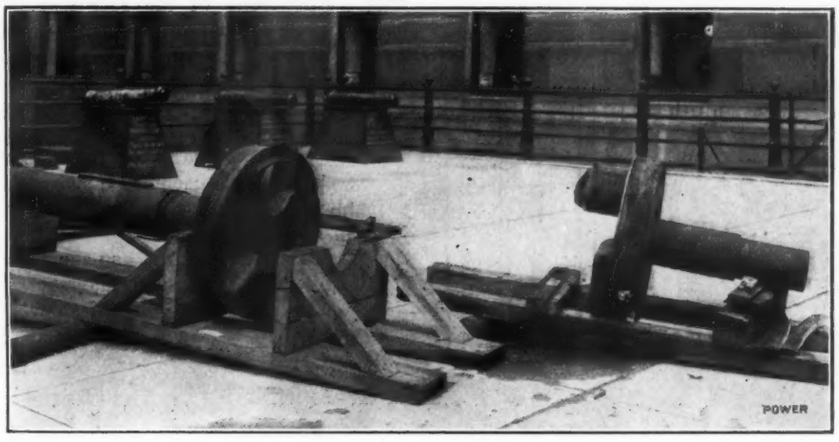
Chardon, Ohio.

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues

Designing a Bearing

I have read Prof. Heck's criticism, in the Jan. 23 number, of my article in an earlier issue. He must admit that there is a considerable difference between a bearing with a steady motor or belt stress and that of a reciprocating engine with its alternating stresses. In accordance with his theory, a single setscrew would hold a quarter box on an engine. This has been tried only to fail, because with the constant changing of the thrust from one side to the other, and the consequent flexure of the shaft, the setscrew forms a kind of hinge for the quarter box to rock upon.



BROKEN SHAFT WHICH RAN IN POORLY DESIGNED BEARING

Two setscrews are now generally used, whether the engine is of the side- or center-crank type. I have seen cases where a vibration which could be felt when standing upon the cement floor could be stopped by setting up on the setscrews of the quarter box, especially on those next to the crank.

I have seen lots of other bearings in trouble from this same cause, and crankshafts with such bearings, although very heavy, fail right along. The accompanying figure is of a very large crankshaft which was run in the bearing referred to in my article, and I hope later to present photographs showing the wabbling of the wheel being recorded by a deflection gage, and also of the wrecked wheel. This matter cannot be treated the same as the stresses on a crane hook or a hydraulic lift, but is one of those examples where two forces are acting in unison, one due to the vibratory effect of the flywheel and the other to the pressure upon the piston.

When Prof. Heck says that there is no high-speed engine on the market the shaft of which is light and flexible enough to permit serious vibration of this sort, he betrays lack of experience with or observation of this kind of engine in actual operation. Those who have had to make these cranks over in considerable numbers have different views, and I know that solid-crank failures are fewer with engines having wedge or two-screw quarter boxes.

His statements about flexible bearings for line-shafting and steam turbines are all right, but they do not apply to the case.

C. R. McGAHEY.

Baltimore, Md.

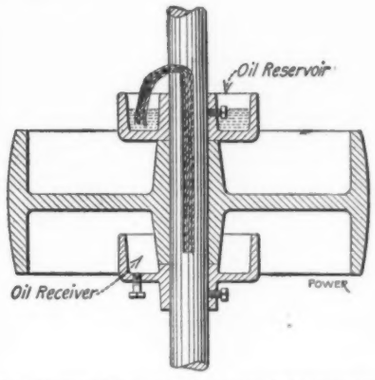
Muleshaft Lubrication

A. E. Derby, in the Jan. 9 issue, tells how he overcame a troublesome muleshaft by increasing the size of the pulley so as to reduce the speed to 180 r.p.m.

In the plant of which I have charge there are two mule drives; one carries a 16-in. heavy double belt 94 ft. long and the other a 14-in. heavy double belt 86 ft. long.

The accompanying figure shows the oiling arrangement I designed for these drives. The pulleys run at 450 r.p.m. and have never been repaired, although in constant service for nine years; they run as smoothly as when they were first put on and not one drop of oil has reached the belts from these pulleys.

The pulleys are of cast iron, not bushed; the hub is long, being only 1 in. shorter than the face of the pulley; the shafting is of turned steel. The oil reservoir and receiver are of cast iron and act as collars. The oil groove in the shaft is 3/8 in. wide and 7/8 in. deep, holds about four strands of candle wicking and is cut in the shaft just opposite to where the pressure of the pulley comes.



ARRANGEMENT FOR OILING MULESHAFT

The oil reservoir holds about ½ gal. of oil and has to be refilled about every two weeks; we renew the wick once a year. To do this, we put a prop under the pulley and loosen the setscrew on the oil receiver and drop it; then pull the old wick out, soak the new one in oil and pull it through with a piece of wire.

JOHN HOPKINS.

Quincy, Ill.

Kerosene in Blowoff Pipe

In reference to Mr. Stambaugh's letter in the Jan. 9 issue under the above caption, I suggest that the oil in the blowoff pipe and valve was trapped by a depression somewhere along the elevation of the blowoff system; otherwise it certainly ought to have risen to the surface of the water in the boiler.

Whether the trap was caused by the conformation of the blowoff system or whether it was temporarily caused by scale sticking in the pipe is for Mr. Stambaugh to decide. I do not think that there would have been any danger of an explosion had the oil not leaked out.

JOHN S. LEESE.

Manchester, England.

Plugged Boiler Head

The plugged boiler head described by W. G. Walters in the Dec. 26 issue brings to my mind a somewhat similar case in my experience.

The manager of a large hotel ordered from a reputed reliable foundry company, a large cast-iron steam-roasting kettle, and they were notified that a steam pressure of 80 lb. would be used in the kettle.

The kettle was made and delivered. The engineer in charge put a cold-water test pressure of 200 lb. upon the kettle and no leak showed. It was then connected and put into use and in a few days a leak showed on one side of the kettle. Upon examining and testing around the leak, a flaw was discovered in the casting from ¼ to ¾ in. wide and over 9 in. long. This space had been filled with a metal similar to babbitt, and after this had been well calked, the spot had been colored to resemble the iron.

The foundry was notified and the head of the casting room confessed that he was responsible for filling the cavity with soft metal. Of course, a new kettle was supplied.

In my estimation, a person who will do tricks of this kind should be severely punished, for several lives might easily have been lost if the kettle had gone to pieces while in use.

JOHN THORN.

Toronto, Ont.

Engineers' Wages

In almost every issue space has been given to the under-paying of engineers.

The fault lies with the engineer himself. Of most classes of men, the engineer is the least progressive. By progressive, I do not mean that he does not advance in knowledge, for he is usually industrious, but he lacks the push and courage to go to the "man higher up" and make suggestions or even ask for a well deserved raise. This is true of almost all shop employees; they are slow in coming forward, preferring to sulk and stay behind till they are driven to leave and look for something else.

Let any engineer who thinks he does not get a just return for what he gives his employer, ask himself if he has ever done anything toward getting higher wages. He has read much, seen where improvements could be made to good advantage in his engine room, but has he ever taken the matter up with his chief instead of telling the fireman that "if we installed a ———, we could save a whole lot"?

That is where all the trouble lies. If he gets good returns out of his machinery, why, this is what is expected of him; he is paid to do that, and it is seldom that a superintendent will, on his own initiative, say, "Well, Bill, I see you have been doing excellently; from Saturday on you will get an increase."

The engineer is on the spot, he sees where improvements can be made, and it is from him that suggestions and recommendations should come. In this way alone, it seems to me, will the present position of the operating engineer be elevated.

NATHAN OWITZ.

New York City.

Breakage of Separator Gage Glasses

J. W. Dickson's letter in the Jan. 9 issue refers to a condition which has interested me, and I have often heard other engineers refer to the same subject.

I believe this solution to be correct: Steam and water pass through the separator at high velocity. As the glass offers a path there will be a flow through

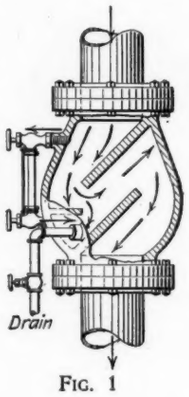


FIG. 1

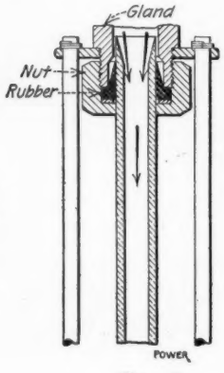


FIG. 2

it, as shown in Fig. 1, especially when the separator is well drained of water. This flow can be detected by observing the little slugs of water intermittently projected through the glass. The wear of the glass can be seen on an old used glass as they usually wear thin at the top end, as shown in Fig. 2.

WILLIAM C. THORNE.

Vineland, N. J.

Follow Up Methods

Under the heading, "Using the Firm's Stationery," we have had several examples of follow-up methods. My experience with one concern has "queered" it with me for the future. I wanted to buy a flue cleaner and as practically all the manufacturers advertised their machines on trial, I wrote to three of them, asking the following questions: "What is the price of your cleaner? Have you any circulars explaining its construction and operation? What kind of power do you use? Will you send it to be tried out against several others?"

Two of them sent the desired reply. The first I heard from the other was through our general manager. He found the cleaner in the receiving room and told me to return it without trial as he would not use that type of machine. There really was nothing against the cleaner but the manager's prejudice, but his word was law, and back it went. A letter explaining the situation went with it and was the beginning of a long correspondence.

The manufacturers wrote me of the saving to be made, of its amazing wearing qualities and of the small amount of power it required, and they answered all my criticisms. They also sent me the names of everybody who had ever used the cleaner, accompanied by enough testimonials to make the patent-medicine people look sick; one of them was from the makers of our own boilers.

My position was very uncomfortable, for I agreed with them in all their arguments but did not dare to admit it. Had I written them acknowledging the merits of their machine, they would undoubtedly have forwarded a copy to our manager. Knowledge of the fact that we had bought a competitor's machine failed to stop the flow of letters, but our indifference finally ended the matter.

The foregoing example of follow-up methods may be good business, but had these people answered my letter instead of forwarding the machine, they would probably have made a sale, as I liked their machine the best and could have convinced those higher up, had the manager not expressed a snap judgment.

JOHN BAILEY.

Milwaukee, Wis.

Corresponding with Manufacturers

Reading C. E. Henry's letter, "On Quoting Prices," in the Jan. 23 issue, reminded me of an incident that occurred some time ago when an air pump failed.

After locating the trouble, which was due to worn parts, I immediately wrote the manufacturers, asking them to send me by return mail a descriptive catalog showing the various parts. I gave them the size, type and number on the name plate of the pump, also the date of its purchase. My letter was written on the company's stationery, but I cautioned them to address me and gave my home address.

In about three weeks the manager handed me a letter addressed to the company, "Attention Mr. Dickson." Its contents were something like this: "We are mailing you under separate cover a catalog of our latest pattern air pump, also a price list of duplicate parts." They did not mention the old-style pump, and this later pattern was entirely different from the one we had. After a delay of about 40 days, I decided to have the parts duplicated at a local shop.

J. W. DICKSON.

Memphis, Tenn.

What Means the Dome?

I think that the following will answer the question raised in the letter under the above in a recent issue:

The South is what the Northern man would term "The Land of Wonders" when it comes to looking over a logging road. Some of the hills over which these little logging locomotives haul eight or ten carloads of logs are a caution.

The water tanks from which these dummies draw their supply are ponds close to the track, full of mud, moss and decayed wood which naturally cause the boilers to foam, and the engineer with 10 cars of logs behind him, a good stiff 6 or 7 per cent. grade ahead, dinner ready at the other end and 10 miles to go, could not stop if he would, so on many of the locomotives they have tried different methods to avoid priming. The dome on the locomotive in question is probably one of the means to this end.

B. F. BROWNE.

Yellow Pine, Ala.

The Handicap of Equipment

One phase of the isolated-plant question that is sometimes not taken into account when saying that the engineer is at fault if he does not show a saving over central-station prices is the ridiculously unmechanical "hook up" of the plant and the poor machinery with which he sometimes has to work.

The most extreme case under my observation was in a plant which should have been laid out for the combined service of light, heat and power. Every factor was favorable; the buildings were all close together on a side hill, the power house could have been put anywhere on the lower side and an unfailing supply of soft water could have been brought by gravity to the boiler room by laying not over 500 ft. of pipe.

There was nothing to hinder running the exhaust mains underground and nine-tenths of this work could have been done by inmates of the instituation. Who the consulting engineer was, if there was one, I do not know, but in the first place there was probably somebody with about 15 heaters to sell who had a friend on the board of governors. These heaters, of course, are burning expensive hard coal. Added to these is a second-hand engine and a shunt-wound, 110-volt dynamo where a 220-110-volt three-wire system would have been more satisfactory. Two vertical boilers complete the outfit, using city water which is the hardest water I have ever seen.

It is reasonably certain that with good apparatus and a vacuum-heating system, the exhaust would do three-fourths of the heating in ordinary winter weather and the total soft coal burned for all light, heat and power would not cost more than the hard coal used for heating alone under the present system. In order to get started right now it would mean throwing away nearly everything and beginning at the bottom.

No engineer can combat conditions like these and compete with the figures offered by the central station.

V. L. BARBER.

Punxsutawney, Penn.

The Standard of Consulting Engineers

I noticed the editorial in the Feb. 6 number on "The Standard of Consulting Engineers," and I take pleasure in pointing out that an organization has been in existence in this country, called the American Institute of Consulting Engineers, for several years, being formed prior to the English organization.

The American Institute commenced first in 1905 with a small body of professional engineers who were largely concerned with architectural engineering, and about two years ago it enlarged its scope so as to include all branches of the profession. Its membership (61) contains some of the leading engineers of America, representatives of the different branches, civil, electrical, mechanical, and has already adopted a code of ethics and schedule of fees.

Following this example, an organization of consulting engineers has been formed on the Pacific Coast called the Association of Consulting Engineers of the Pacific Coast, the secretary of which is C. Dorleth, Jr., of Berkeley, Calif.

E. W. STERN.

New York City.

Took Gases from the Uptake

The articles on burning uptake gases by Messrs. Breckenridge and Steely, in recent issues of POWER, interested me. I had opportunity to test an arrangement similar to the one described by Mr. Breckenridge with the following exceptions, to wit:

First. An engine-driven fan was used in lieu of the steam jet.

Second. The recirculating pipe was provided with an opening controlled by a suitable damper, through which boiler-room air was drawn to "sweeten up" the uptake gases.

Third. A damper was provided in the recirculating pipe and ahead of the fresh-air opening to control the amount of recirculating gases independently of the fan.

The apparatus was a so called smoke consumer and fuel economizer and had been installed by the promoting company on a rigid guarantee of abolition of the smoke nuisance and a substantial fuel saving.

Evaporative tests were conducted with and without the apparatus in use, and while they were not entirely satisfactory from an evaporative standpoint, the draft readings and the gas analyses were conclusive proofs as to the merits of the apparatus.

Draft readings with the apparatus in use showed the draft in the uptake to be greater than the suction of the fan, and the analyses of the fan-discharge gases gave results identical to boiler-room air which alone showed that the apparatus was not being operated in accordance with the installers' claims, and this condition existed after the installing engineer had advised us that adjustments had been made whereby the claims of the company were being fulfilled.

After attention was called to the condition of the drafts, an attempt was made to circulate furnace gases only, but was soon given up as the steam pressure steadily dropped, in spite of the fact that the firing was almost continuous, and in addition to this the escaping gases blown out of the fire-doors and leaks in the setting were so oppressive that they were unbearable.

The claim of the company that its apparatus takes smoke from the smoke breeching, mixes it with air and returns it to the furnace and there consumes it was not substantiated by the tests. As a matter of fact, the results were very much poorer when the attempt was being made to exhaust gases from the breeching and return them to the furnace than when air was taken wholly from the boiler room independent of the breeching in the same manner as in all ordinary forced-draft equipments.

The conclusions drawn from these tests were that the apparatus was without merit.

J. B. HARRIS.

Minneapolis, Minn.

Underfeed Stoking vs. Overburning

I cannot make some of Mr. Woolson's statements agree with my conception of furnaces and the chemistry of combustion.

In one place he states, "It is impossible to get perfect combustion and maximum temperature under a boiler by feeding the coal up from below, and forcing air up through the incandescent mass of fuel, although it is possible to obtain high temperature in the mass of fuel itself." As we know that it is impossible to maintain perfect combustion, we must suppose that he means comparatively perfect. His statement then is that comparatively perfect combustion cannot be obtained with an underfeed stoker because, as he adds later, of the deep fire above the tuyeres, driven by a forced blast from below.

Mr. Woolson endeavors to show us how "the air on entering from the ashpit gives out its oxygen to the glowing carbon on the bars and generates much heat in the formation of carbon dioxide." And that these CO_2 molecules, on rising through the remainder of the fire, take up another atom of carbon, making each CO_2 molecule change to two molecules of CO, in which condition, due to lack of oxygen, they pass through the uptake with the resultant loss.

The visual testimony of the formation of CO_2 in any great quantity in a furnace is a more or less white fire, while that of the formation of CO is an orange or reddish fire. Has any reader ever looked through a properly appointed observation hole of an underfeed furnace where no air was admitted over the fire and noted a fire burning white in under and red on top? Never having seen it myself, I cannot help thinking that Mr. Woolson must, in some manner, have got his fire upside down.

The fact that the elements of combustion—coal and air—are fed from in under, through and between the tuyeres of an underfeed stoker at or near boiler-room temperature, makes "glowing carbon on the grate bars" or tuyeres an impossibility in an operating furnace. The temperature at the grates is low, but rises with the elevation of the fuel; reaching maximum at or above the fuel bed.

Underfeed stoking produces at least two zones of combustion. The first and nearest to the tuyeres might be termed the coking zone, where, due to the low temperature of vaporization of hydrogen, the different hydrocarbons are distilled or liberated from the coal in the pressure of the entire air supply of the furnace, ready to unite chemically with the oxygen in the air when the proper temperature is reached. The other zone is that part above the coking zone having a temperature exceeding that of the vaporization of carbon.

Due to the formation of the fuel bed, the air passes through it in streams or irregular columns which, though small when compared with visible objects, are, when compared with the size of molecules, of immense proportions. As the vibratory action of the carbon molecules is of insufficient magnitude to project them into this air column, the atoms of carbon can only come in contact and be saturated with such oxygen atoms as are exposed and clear of four times their volume of nitrogen on the outer atomic film of the air. After this no more oxygen is available until friction and molecular disturbance have displaced the intervening nitrogen, without considering argon and several other substances present in the air in small quantities.

All this goes to show the process of combustion is so slow under practical conditions as to make it impossible for the air to give up all its oxygen on or near the grate bars, and that the passing of oxygen through the fuel bed into the combustion chamber for the benefit of the unburnt gases is merely a problem of draft pressure, to be determined by gas analysis and experimental speed ratios of blower and stoker. This determination is made on the installation of most stokers, the blowers being so speeded as to force through the fire the minimum amount of excess air consistent with maximum combustion. Flue-gas analyses made during stoker tests, many of which have been published, will show this to be a fact.

The natural-draft, hand-fired, stationary-grate furnace, without smoke consumers or means of admitting air over the fire other than through the fire-doors, will, if intelligently stoked, and without air holes due to lack of fuel, produce rather high percentages of CO_2. Still, such a furnace provides the conditions—"where air has to pass through a body of incandescent carbonaceous matter"—which Mr. Woolson informs us would produce only CO.

WILFRED E. BERTRAND.

Philadelphia, Penn.

Smoke Prevention with Steam Jets

I was interested in the article under the above title in the Jan. 16 issue, and especially in the Ringelmann chart readings shown in Fig. 4 thereof, which show the performance of the plant with reference to smoke before the steam jets were applied and after they were put in use.

The article says: "A comparison of the two charts utterly fails to indicate the degree of smoke abatement accomplished." I would like to state that the lower chart also utterly fails to show the large amount of smoke that was actually made during this test. The chart was made by taking one-minute readings and I believe that this method is not accurate enough to give an idea of the performance of the stack.

In Chicago we take 15-sec. readings according to the Ringelmann chart. The accompanying figure shows a section of a Ringelmann chart plotted from 15-sec. observations. The density of smoke as given is the average density for the 15 sec. previous to the time stated and not the density at the instant of recording the smoke. A record made in this way, therefore, gives a more accurate indication of the actual smoke made and the length of its duration. The figures on the base line of each record indicate the number of scoopfuls of coal fired. I do not believe it is generally appreciated how closely smoke is read in Chicago.

It has been found by experience that steam jets in themselves could not be considered a complete solution for the smoke problem, although in many cases they offer a great advantage, and when used with proper furnace construction and brickwork in the combustion chamber, make a combination which can easily run inside of the Chicago ordinance.

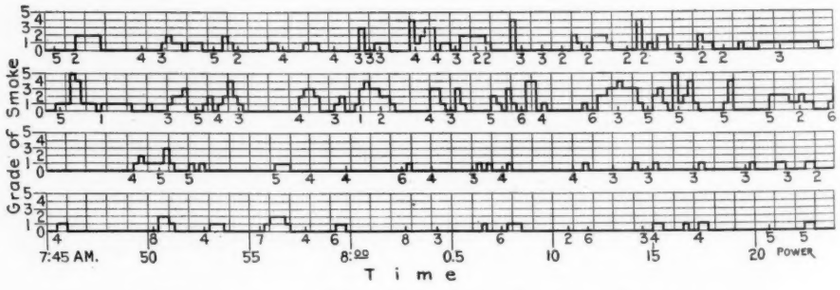
O. MONNETT,
Smoke Inspector.

Chicago, Ill.

The "Clean-up" Spirit

I like the spirit of that story appearing on the foreword page of the Jan. 30 issue of POWER.

It must not be inferred that the firemen mentioned as "a clean-looking set of men" were at that moment clad in spotless garments, with faces free from grime, but it was apparent that there was a "clean up" with them at quitting time, while with the chief there was not.



SECTION OF SMOKE CHART BASED ON 15-SECOND READINGS

I expect there was a decent place for the men to dress in and hang their street clothing in this plant. In many places one takes chances and places his clothing where he believes there is the least coal dust, etc.

Suitable accommodations can easily and cheaply be made in most plants for hanging up clothing and for the men performing their ablutions. These should be provided in every case to encourage the "clean-up" spirit.

LLOYD V. BEETS.

Nashville, Tenn.

Inquiries of General Interest

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it

Outside Diameter of a Gear

What is the rule to find the outside diameter of a gear?

M. O. R.

To find the outside diameter of a gear with standard teeth, divide the sum of the number of teeth plus two by the diametrical pitch. Expressed as a formula, it would be

$$\frac{\text{Number of teeth} + 2}{\text{Diametrical pitch}} = \text{outside diameter}$$

If the teeth are not standard, the rule is the sum of the pitch diameter and the product of the addendum multiplied by 2. A standard tooth is one in which the line of pressure is 14.5 deg.

Heat Required to Convert Ice to Steam

What amount of heat would be required to transpose 10 lb. of ice at 18 deg. F. to steam at 30 lb. pressure absolute?

L. R. G.

The total heat of 1 lb. of steam at 30 lb. pressure absolute above 32 deg. F. is 1163.9 B.t.u. The heat required to convert 1 lb. of ice at 18 deg. F. to water at 32 deg. F. is the sum of the latent heat of ice and the product of the rise in temperature of the ice multiplied by its specific heat. Substituting figures, the rule would be expressed thus: $142 + (14 \times 0.504) = 149.056$ *B.t.u.* The heat required to raise 10 lb. of ice to steam at the above pressure is

$$(1163.9 + 149.056) \times 10 = 13{,}129.56 \text{ B.t.u.}$$

Load Raised by Drum

If the average pressure on the piston is 60 lb., what load will a 24x36-in. engine connected direct to an 8-ft. drum raise in one revolution?

L. W. R.

An engine of 24 in. cylinder diameter contains 452.4 sq.in. and the pressure on the piston is

$$452.4 \times 60 = 27{,}144 \text{ lb.}$$

In one revolution the engine will develop

$$27{,}144 \times 3 \times 2 = 162{,}864 \text{ ft.-lb.}$$

per revolution. One revolution of the drum will raise the weight

$$8 \times 3.1416 = 25.133 \text{ ft.}$$

and the pounds raised by the drum in one revolution are

$$\frac{162{,}864}{25.133} = 6480 \text{ lb.}$$

Ampere Load to Raise Coal

What would be the ampere load on a 250-volt motor to raise 2500 lb. of coal 150 ft. in one minute if the efficiency of the apparatus is 50 per cent.?

R. L. W.

To raise 2500 lb. of coal 150 ft. per minute would require

$$2500 \times 150 = 375{,}000 \text{ ft.-lb.}$$

The horsepower required would be

$$\frac{375{,}000}{33{,}000} = 11.36 \text{ hp.}$$

The watts expended in raising the coal would be

$$11.36 \times 746 = 8474.56$$

The amperes required to raise the coal would be

$$\frac{8474.56}{250} = 33.9$$

If the overall efficiency is 50 per cent., the total amperes required are

$$\frac{33.9}{0.50} = 67.8$$

Soldering Aluminum

If aluminum can be soldered, what is the best material to use?

F. E. J.

Aluminum can be readily welded electrically, but soldering is not satisfactory. The high heat conductivity of the aluminum withdraws the heat of the molten solder so rapidly that it "freezes" before it can flow sufficiently. A German solder said to give good results is made of 80 per cent. tin and 20 per cent. zinc, using a flux composed of 80 parts stearic acid, 10 parts chloride of zinc and 10 parts chloride of tin. Pure tin fusing at 480 deg. F. has been employed as a solder, and soft solder with chloride of silver as a flux has also been used.

Receivers

Why is no receiver required for a tandem-compound engine?

J. D. R.

Both high- and low-pressure pistons of a tandem-compound engine transmit power to a single crank. The exhaust from the high-pressure cylinder can enter immediately into the low-pressure cylinder for the next stroke. With a cross-compound engine with cranks on the quarter, there is an interval of time between the exhaust of the high-pressure cylinder and the admission of the low-pressure cylinder; and the receiver is provided to store the discharge of the high-pressure cylinder during that period.

Power for Machine Tools

What power is required to drive a 36-in. lathe and a 15-ft. planer?

P. H.

A 36-in. lathe will require about 15 hp. Planers are rated by their capacity under the rail, and one 15 ft. long will require from 2½ to 7½ hp.

Effective Head

What is considered the effective head in a hydraulic turbine?

D. B.

Neglecting friction, the effective head with an impulse turbine is the distance from the level of the upper pool to the point of entry. The effective head cannot be increased to the level of the tailrace by employing draft tubes. In the reactance turbine the effective head is measured from the level of the upper pool to the point of exit. If draft tubes are employed, however, this head can be increased, within the limits of the atmospheric column, to the level of the tailrace.

Adjusting a Spring-Loaded Safety Valve

What will cause a spring-loaded safety valve to rumble on its seat, and how can it be remedied?

P. J. L.

If the safety valve does not pop cleanly or shows a tendency to rumble, the ring surrounding the valve which forms a huddling chamber is too low and should be screwed up.

Running a Condensing Engine Noncondensing

If the condenser of a compound-condensing engine running full capacity should become disabled, what should be done to keep the engine running on full load?

A. L.

Open the relief valve, let the engine exhaust to the atmosphere, and let high-pressure steam into the low-pressure cylinder through the bypass valve.

New York Chapter of Heating and Ventilating Engineers

The regular monthly meeting of the New York Chapter of the American Society of Heating and Ventilating Engineers was held in the Engineering Societies Building, 29 West Thirty-ninth St., New York, Tuesday evening, Feb. 13, at 8 o'clock, with President W. M. Mackay in the chair. The evening was devoted to routine business and a discussion on the subject of factory ventilation.

Announcement was made that at the March meeting two topics of interest will be presented: "Ventilation of Public Schools with Especial Reference to New York Practice," Mr. McCann, of the Board of Education, presenting some facts in regard to the New York schools, and "The Time Element in Regard to the Starting Up of House Heating Boilers."

At the April meeting the subject of "Air Washers and Humidity" will be discussed, and at the May meeting, "Artificial Cooling of Buildings, Steam Traps and Vacuum Systems."

$500,000 Plant Burned

On Feb. 6, fire destroyed the plant of the Barnard & Leas Manufacturing Co., at Moline, Ill., causing a loss of $500,000 and throwing 400 men out of employment. An explosion of accumulated gas in the furnace of one of the boilers set fire to a pile of shavings and the fire quickly spread over the entire building.

Water Tube Boiler Explodes

On Feb. 19 a water-tube boiler exploded at Wiggins, Miss., killing three employees and injuring the head fireman. Further particulars will be given in an early issue.

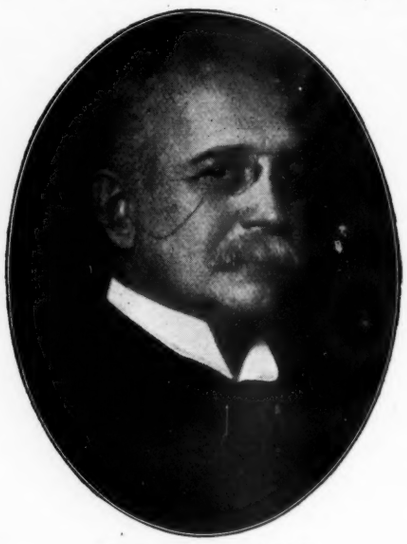
OBITUARY

John Burkitt Webb, who retired from the professorship of mathematics and mechanics at the Stevens Institute of Technology five years ago to practice his profession of consulting engineer, died at his home, in Hoboken, N. J., Feb. 18, at the age of 71. The funeral was held at the Church of St. John the Evangelist on Feb. 20, the burial taking place in Philadelphia.

Mr. Webb was a member of numerous scientific societies, and was known as the inventor of many devices for the measurement of power, among them being the dynamophone.

Mr. Webb was born in Philadelphia, Penn., in 1841 and received his engineering degree from the University of Michigan in 1871. He supplemented his course by extensive study at the universities at Berlin, Heidelberg and Paris, afterward becoming professor of civil engineering at the University of Illinois and later assuming the chair of applied mathematics at Cornell University. He went to Stevens in 1885. Mr. Webb married Miss Mary Emeline Gregory in 1870.

On Feb. 18, Francis H. Stillman, president of the Watson-Stillman Co. and prominent in the machine-tool and hydraulic-engineering field, died at his



FRANCIS H. STILLMAN

home, 105 Rodney St., Brooklyn, N. Y., in his sixty-second year. Mr. Stillman was born in New York on Feb. 20, 1850, and attended Yale College, from which he was graduated in the class of 1874, having received the degree of bachelor of science.

Mr. Stillman first embarked in business with the Cottrell Printing Press Co., severing this connection to engage in business with his step-father, Mr. Lyons. The firm of Lyons & Co. was succeeded in 1883 by Watson & Stillman, which firm was organized by Mr. Stillman. In 1904 it was incorporated as the Watson-Stillman Co., with Mr. Stillman as its president, which position he continuously occupied until his death.

His business ability soon placed the company in a very prominent position in the hydraulic-engineering field, and upward of 4000 types and sizes of hydraulic machines have been built by it.

Mr. Stillman was a member of Hyatt Lodge, F. and A. M., a member of the Thirty-second Degree in Aurora Grata Consistory, a Knight Templar, a Noble of Kismet Temple, Mystic Shrine, and of the Royal Arcanum, the Hanover Club of Brooklyn, the Engineers Club, the American Society of Mechanical Engineers, and treasurer and continuously throughout its existence, a director of the National Association of Manufacturers. He organized and was first president of the Machinery Club of New York, and was also first president of the National Metal Trades Association. He was also president of the Bridgeport Motor Co. and of the Pequannock Commercial Co., and a director in other manufacturing firms.

The many friends who loved Mr. Stillman for his high standard of business integrity, his genial disposition and for his kind personal interest in all those about him will feel most keenly his sudden death, particularly those at his office, as he came to business the day before his demise, and apparently was in good health.

Funeral services were held at his late home at eight o'clock Tuesday evening, Feb. 20, which would have been his sixty-second birthday, and the body was interred at Evergreen Cemetery, Brooklyn, on Feb. 21. Mrs. Stillman (who was Miss Irene A. Bancroft, of Boston, Mass.) and two sons, Austin F. and Edwin A. Stillman, survive him.

SOCIETY NOTES

The National Association of Stationary Engineers of New Jersey will hold its twenty-first annual convention in Newark, N. J., May 30 to June 2. It is the intention to make the exhibition a combination of a power-plant exhibit and a businessmen's exhibit, and arrangements have been made to accommodate about 100 exhibitors. Any further information may be had by addressing E. W. Sears, secretary of the convention committee, 109 Eleventh Ave., Newark, N. J.

PERSONAL

Edward C. Wright, Jr., has been appointed smoke inspector of Kansas City, Mo.

Albert R. Talcott, until recently chief engineer with Tiffany & Co., jewelers, at Forest Hill, Newark, N. J., will represent the Standard Oil Co. in northern New Jersey.

Hubert E. Collins, secretary of the Institute of Operating Engineers, has entered upon an extended trip to Brazil in a consulting capacity for J. G. White & Co., New York City.

Cadwallader Evans, Jr., superintendent of power for the H. W. Oliver power plant at Pittsburg, Penn., has resigned to become superintendent of mines and plant of the Arcadia Coal Co., Pictou, N. S.

John Williams, Commissioner of Labor of New York, has been invited to participate in a discussion on factory ventilation by the New York Chapter of the American Society of Heating and Ventilating Engineers at its April meeting in the Engineering Societies Building.

Moments with the Ad. Editor

We have had much to say on this page about the wisdom of reading ads and buying advertised goods. We have pointed out definitely enough that the advertiser *must* make his goods live up to the printed story of them or quit advertising.

We have shown that it only *pays* to advertise when the goods are worth *paying for*.

Now comes a subscriber of ours, J. W. Fries, of Middleboro, Mass., who says it all and says it better than we ever have.

He's got the "brass tacks" of the whole situation in this letter.

"As POWER advises the purchase of advertised goods only, I wish to give our experience to show how we were 'stung' by a certain concern. First, I wish to say that they do *not* advertise in POWER.

"A representative of this concern called at the plant one day, with samples of belt dressing that he praised in glowing terms. It would do wonders to an oily belt we had on one of our engines. I was skeptical because I knew from experience what treatment this belt required, but being on the lookout for anything that would be a benefit to the plant, and thinking he might have just what he claimed, and that it would do the work on this belt, I consented to let him send a *small sample* to try it out. If it did not prove entirely satisfactory and do as he represented (he was to call in a month to see how it worked), we were to hold it subject to their shipping instructions. A 5-*gallon sample* of the dressing came, and we used it strictly according to instructions.

"Say, you have heard of greased lightning. Well, that is the way that belt slipped around the pulleys. There was nothing to do but shut down, clean the belt with gasoline and scrape all that dope off again! We had to feed rosin after we got running. We waited a month for the agent to call, but he never came back. We notified them of the result of the trial and requested shipping instructions, but did not hear from them for nearly a year, when a bill came for $9.50 for 5 gallons of belt dressing. The manager refused to pay it and the bill was put into the hands of a lawyer to collect. They finally agreed to settle for $2.00.

"We still have the 5 gallons of dressing and anyone that wants to try it can have it with pleasure, but with prospects of trouble from its use.

"Moral—read POWER ads. and buy advertised goods."

Note the treatment Mr. Fries' concern got—poor dressing, no promises kept, no satisfaction and a threatened law suit.

Fine business, what?

Do you imagine that manufacturers of belt dressings who advertise them regularly and consistently would handle a case that way?

Not in a thousand years!

Advertisers know that they must make their advertising pay by getting the *permanent good will* of their customers.

And that's one reason why they *take care* of people who come to them as purchasers of their goods.

Yes, Mr. Fries, you are right—

Read advertising in reputable papers and buy advertised goods.

NEW EQUIPMENT

Winters, Tex., will install a water-works plant.

Chesterfield, N. H., will install a street-lighting system.

G. D. Holliday will construct a water-works system in Berea, Ky.

Maricopa, Calif., is having plans prepared for a water-works system.

lighting system in the business district. George C. Hinckley is city engineer.

Poulsbo, Wash., is considering the construction of a water-works system.

Lynnville, Tenn., is considering the installation of an electric-light plant.

Plains, Mont., is considering the installation of a street-lighting system.

Hastings, Neb., is considering the installation of a street-lighting system.

Sutherlin, Ore., will construct a water-works system. Estimated cost, $30,000.

E. T. Glaze, Edna, Tex., will make improvements to his electric-light plant.

The Alamo Lighting & Power Co. will construct a power plant, at Alamo, Tenn.

Redlands, Calif., is considering the installation of an ornamental street

Valley City, N. D., will install a street-lighting system in the business district.

Cœur d'Alene, Idaho, plans the installation of a municipal water-works system.

Fredericksburg, Tex., will install two new dynamos in the local electric-light plant.

The Connecticut Sumatra Tobacco Co., Manchester, Conn., will install a 35-hp. engine.

Milliken, Colo., will construct a water plant in the spring. Estimated cost is $15,000.

Kapowsin, Wash., will install a modern water-works system. Edward Fix is interested.

C. M. Madison is interested in the installation of an electric-light plant, at Sibley, Iowa.

Loveland, Colo., will construct a municipal electric-light plant. Estimated cost, $100,000.

The municipal electric-light and power plant at Marlow, Okla., has been destroyed by fire.

The American Agricultural Chemical Co., Detroit, Mich., will erect a new power power house.

H. C. Westover, Kansas City, Mo., is preparing plans for a water-works system, at Little River, Kan.

William Scheele and D. Thran are considering the installation of an electric plant at Gardenerville, Nev.

Freeman, S. D., is considering the installation of an electric-light plant. Mathias Hafner is interested.

Hillsboro, Ore., is considering the construction of an electric-light and power plant. Estimated cost, $31,000.

Estherville, Iowa, is considering the construction of a municipal electric-light plant. Estimated cost, $65,000.

The Muddy Valley Irrigation Co., Las Vegas, Nev., will construct two electric-power plans for irrigation purposes.

Floodwood, Minn., is considering the installation of a municipal electric-light plant. M. M. Hingeley is interested.

Fort Branch, Ind., will construct a water-works system. Estimated cost, $20,000. William Walter is interested.

The Rochester Last Works will construct a power house, on University Ave., Rochester, N. Y. Estimated cost, $10,000.

The Merchants Association, Youngstown, Ohio, contemplates the installation of a street-lighting system, on Federal St.

The electric-light plant owned by O. Odum, St. Pauls, N. C., was recently destroyed by fire. The plant will be rebuilt soon.

Calgary, Alta., is contemplating the installation of a street-lighting system, on the principal streets. Estimated cost, $10,000.

Berlin, Wis., is considering the installation of a municipal electric-lighting plant in connection with its water-works system.

Council Bluffs, Iowa, is considering the installation of a street-lighting system on various streets. E. Stimpson is city engineer.

The Dominguez Water Co., Dominguez, Calif., plans the construction of a modern water-works system. Estimated cost, $500,000.

Baldwin, Kan., is considering the construction of a water and light plant. Estimated cost, $70,000. E. Folsom is city engineer.

The Mineral Point Public Service Co. will construct lighting systems in Mifflin, Rewey, Livingston, Montfort, Cobb and Highland, Wis.

The London Electric & Ice Co. will build an ice plant, at Hamilton, Va. E. A. Cockey, Jr., Windsor Hills, Baltimore, Md., is president.

The Commonwealth Power Co. will construct a new power plant, at Jackson, Mich. W. A. Foote, Battle Creek, Mich., is president.

San Bernardino, Calif., is contemplating the installation of a new lighting system in the business district. B. F. Bledsoe is interested.

Rockland, Mass., is considering the installation of a municipal electric-light plant. Plans are being prepared by W. J. Plattner, Attleboro, Mass.

Bishopville, S. C., is considering the installation of a 125-hp. boiler in the municipal electric-light plant. S. P. Sutton is superintendent of plant.

C. M. Wood will install a new power plant, at Elizabethtown, N. Y. The equipment will include a 100-hp. producer engine and a 60-kw., 1100-volt, 60-cycle generator.

The Consumers Electric Light, Heat & Power Co. will construct a power-plant, at Paxton, Ill. J. V. Pennegar, Coatesville, Penn., is manager.

The Citizens Light & Transit Co., Pine Bluff, Ark., will install a 500-kw. turbo-generator in its power plant. T. E. Cherot is general manager.

Bids will be received by T. E. May, chairman of board of improvement, Clarksville, Ark., until Mar. 1 for constructing an electric-light plant.

The Norman Electric Light & Power Co., Norman, Okla., is considering the construction of an electric-light plant. J. C. Jonas and R. C. Hardie are interested.

The Western States Gas & Electric Co., Eureka, Calif., will expend about $100,000 on improvements to its local electric light system. H. L. Jackson is manager.

Bids will be received by E. T. Diefenderfer, Washington Ave., Northampton, Penn., until 7:30 p.m., Feb. 29, for one boiler to be installed in the Washington High School.

Dennison & Stephenson, 120 King St., Calgary, Alta., are preparing plans for the construction of a power house at the National Sanitarium, Weston, Ont. Estimated cost, $16,000.

Olmsted & Gillelen, Los Angeles, Calif., have prepared plans for the construction of a municipal electric-light and water system at Oxnard, Calif. Estimated cost, $25,000.

Media, Penn., is considering the installation of a 75-kw., 2250-volt alternating-current generator and a 100-hp. boiler in the municipal electric-light plant. P. E. Ahern is superintendent of plant.

Bids will be received by Roy Price, town clerk, Oxford, Mich., until Feb. 27, for lighting-plant equipment, including generator, engines, jet condenser with air pump for engine and a switchboard.

Power-plant equipment will be required for the new buildings to be erected for the H. Sophie Newcomb College, New Orleans, La. James Gamble Rogers, 11 E. 24th St., New York, is the architect.

The Philadelphia, Baltimore & Washington R.R. will construct a power plant at Havre de Grace, Md., to supply power for a system of automatic signals. E. F. Brooks is general superintendent, Wilmington, Del.

Bids will be received by the mayor of Pawhuska, Okla., until Mar. 4, for repairs and extensions to the municipal electric-light system. Plans are on file at the office of L. C. Willis, superintendent of municipal electric-light plant.

The Tippecanoe River Electric Power Co. has been incorporated to build a power plant on the Tippecanoe River, near Monticello, Ind. The incorporators are J. W. Silby, A. C. Ayres, W. D. Jones, W. W. Hammond and F. C. Ayres, all of Indianapolis.

Bids will be received by C. B. J. Snyder, Supt. of School Bldgs., until 3 p.m., Feb. 26, for installing heating and ventilating apparatus in the old portion of the Boys' High School, on Marcy Ave., between Madison St. and Putnam Ave., Borough of Brooklyn.

BUSINESS ITEMS

McLead & Henry Co., Troy, N. Y., manufacturers of "Steel Mixture" boiler setting specialties, have opened an office in Boston, 954 Oliver Building, 141 Milk St., to take care of their trade in that vicinity. A. W. Pettie, who has been representing the company in the Middle West, will have charge.

The Kennedy Valve Manufacturing Co., Elmira, N. Y., has put a new hydrant on the market called the "Newtype." This hydrant supplements the Kennedy "Newtype" line in connection with the "Newtype" water gate valve that has had much success since it was placed on the market something over a year ago.

Rapidly increasing business in the Pittsburg district has compelled the H.

W. Johns-Manville Co. (100 William St., New York) to remove their Pittsburg offices from the Liberty St. location to larger quarters at the northeast corner of Wood St. and First Ave., where they will occupy the entire eight-story building.

The Chicago & North Western R.R. Co. have standardized the Vulcan soot cleaner (G. L. Simonds & Co., sales agents, 800 Steinway Building) on both water-tube and return-tubular boilers. To date 71 cleaners have been purchased and the new terminal station in Chicago, containing six B. & W. boilers, is fully equipped. They are now installing the Vulcan cleaners on all of their return-tubular boilers both in their outside plants and in the coal mines. They also recently equipped their coal mines with the Dean boiler-tube cleaner (made by the William B. Pierce Co., Jewett Building, Buffalo) for the purpose of keeping the tubes free from scale.

NEW CATALOGS

Baldwin Locomotive Works, Philadelphia, Penn. Record No. 71. Locomotives recently built for industrial and contractors' use. Illustrated, 32 pages, 6x9 in.

Stromberg-Carlson Telephone Mfg. Co., Rochester, N. Y. Bulletin No. 1003. Telephone supplies and telephone construction material. Illustrated, 206 pages, 8x10 in.

The Denver Engineering Works Co., Denver, Colo. Bulletin No. 1053. Electric hoists. Illustrated, 16 pages, 8x10½ in. Bulletin No. 1054. Richards pulsator classifier, Lauder type. Illustrated, 2 pages, 8x10½ inches.

ENGINEERS WANTED

Under this head are published, without charge, advertisements of actual vacancies in power plants for operating engineers and assistant engineers. For the guidance of applicants for advertised positions, the advertisements must contain particulars to show the class of service demanded and the wages paid. Employers who desire to advertise under this head are requested to write for a blank form of application.

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ENGINEER or superintendent of small electric power plant; eight years' experience, producer gas, oil or steam; employed at present, but desire change; good reasons; married, sober and capable of rebuilding plant if necessary; state salary. Address Box 581, Power.

ENGINEER, New York City license, capable of running and repairing power, electric and ice machine, at present superintendent of apartment house, desires position, city or country; long experience and best references. Box 597, Power.

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FOR SALE

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FIVE CORLISS vertical water leg, and sixteen Manning vertical type boilers. J. P. Coats, Ltd., Pawtucket, R. I.

8x10 SKINNER ENGINE, direct connected to 30-kilowatt generator, and 8x10 Allfree engine, direct connected to 20-kilowatt generator . Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

LATEST MODEL, heavy duty, 18x42 Brown engine, installed 1904; no reasonable offer refused; this engine was operated by builders' engineer; for sale account of removal; splendid equipment, oil guards, lubricators, metallic packing. Box 575, Power.

THIRD ANNUAL magneto bargain sale; imported high tension magnetos at less than cost of importation; our third annual genuine inventory sale of U. & H. master magnetos, made in Germany, is now in progress; all horsepower sizes and types for 1, 2, 4 and 6 cylinder motors, suitable for motor cars, motor wagons, motor boats, motorcycles, stationary engines, etc. Write now, before they are all gone, for circular and price list. This sale is a real magneto money saver. J. S. Bretz Co., 250 West Fifty-fourth St., New York City.

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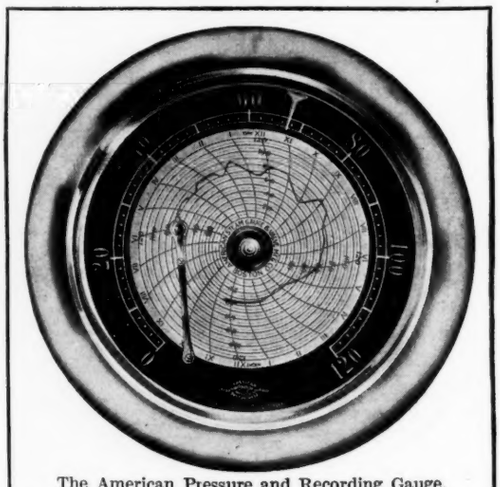

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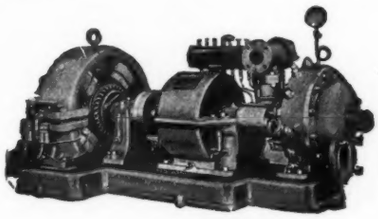

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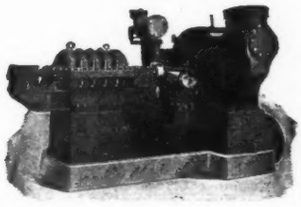

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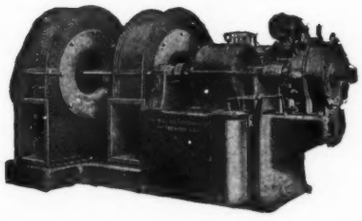

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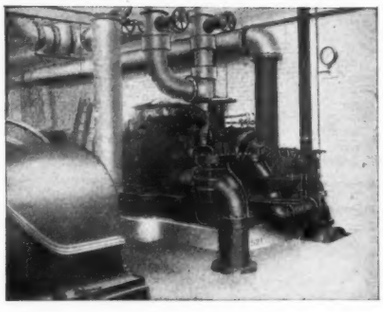

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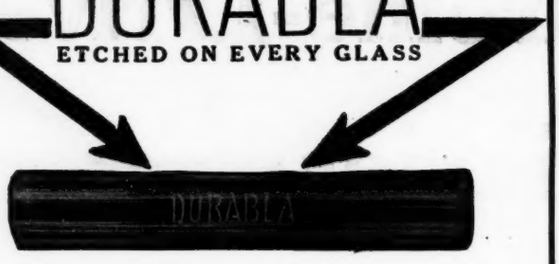

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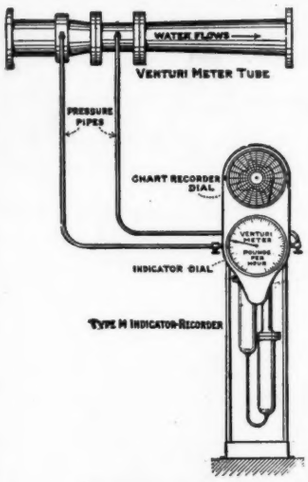

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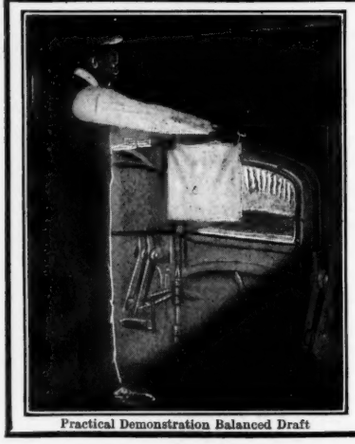

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